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THE PREDICTABILITY OF AUTOMOTIVES TRAINING SUCCESS

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "The Predictability of Automotives Training Success" submitted by John Michael Zurawell in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

This study investigated the relationships between students' cognitive mental ability, mathematics ability, reading comprehension and reading vocabulary to see if any one or combination of these might be used in assisting to predict which students had the best chance for success in the total Automotives program at W.P. Wagner High School in Edmonton, Alberta.

More specifically, the tests were a battery of tests for cognitive processing consisting of Visual Search, Trail-making, Memory for Designs, Figure Copying, Auditory Serial Recall and Digit Span; the W.P. Wagner Mathematics Inventory, and; the Sequential Tests of Educational Progress, reading vocabulary and reading comprehension subtests.

The criterion variable was the students' mark(s) in the various courses offered in the Automotive Program.

The sample consisted of one hundred students (sixty-three from year one, twenty-one from year two, and sixteen from year three) from the three year Automotives Program.

To determine relationships, the test results were subjected to three statistical analyses. The first was a Principal Components Analysis on the entire sample. The second was a Principal Components Analysis on the year one group in the sample. The third was a correlational analysis

of the test results of all those subjects in the sample who had completed all tests given in this study.

The results of this study indicated that:

1. There was a significant relationship between the W.P. Wagner Mathematics Inventory and marks in the Automotive program; and
2. That there was a significant relationship between the Visual Search (mean reaction time) Test and the Trail-making Test and marks in the Automotives program.

Supplementary analysis indicated that:

1. Students' marks in year one of the program are very similar and predictive of those received in subsequent years;
2. Previous research by Das *et al*. on normal and retarded adults and children yielded results similar to that for this population; and
3. Research by Ashman on the interdependence of planning and coding factors also held true for this population.

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CHAPTER I

INTRODUCTION

It is commonly assumed that successful achievement has certain prerequisites including mental ability, adequate academic background, and motivation (Ward, 1974). In recognition of this, many institutions make entrance into a program conditional upon previous academic record and/or acceptable scores in standardized tests.

Often the establishment of minimum admission requirements assumes that the student's previous school record will serve as a predictor of future success in more advanced work. How well this will predict future success in a particular program has been the subject of many studies. This study went further and examined the relationship between students' scores in reading comprehension and vocabulary, mathematics, and their scores in cognitive ability tests (Ashman, 1978) and their success in the Automotives program at W.P. Wagner High School in Edmonton, Alberta.

All students who apply are admitted to the Small Engines course which is the first year of the Automotives program, but approximately only one in five of these students are selected to continue into the second, and subsequently the third year of the program.

This study attempted to look at relationships

between students' reading comprehension, reading vocabulary, mathematics ability and cognitive mental ability to see if any one or combination of these might be used in assisting to predict which students had the best chance of success in the total program.

The Setting

W.P. Wagner High School in Edmonton, Alberta is primarily a vocationally-oriented school for students with various learning disabilities, but normal or near normal intelligence (I.Q. generally between 80 and 100), who have experienced problems with school at the Junior High level. The various learning disabilities displayed by these students may be the result of any one or more of perceptual, intellectual, physical, emotional, social or psychological problems. The one thing that they have in common is that the schools in which they received their Junior High education have identified them as students who would have little chance of success at a regular High School which offered the regular Alberta High School curriculum.

W.P. Wagner High School offers programs which are specially designed for these students. The programs offered to these students are such that each student spends one-half of his/her day in academic classes and the other half in vocationally-oriented classes.

The academic program is designed to help students to develop their individual abilities to the minimum High

school standard in Mathematics, Language Arts and Science. Art, Music and Drama are also included in the academic program to help students develop their self-confidence and provide some outlets for their creativity. The vocational program is designed to give students the opportunity to develop the skills, attitude, responsibility and motivation which are necessary in obtaining and keeping employment in the marketplace.

The vocational programs include the areas of Automotives, Heavy Construction, Millwork and Carpentry, Pipe Trades, Sheet Metal, Machine Shop, Building Maintenance, Foods, Drafting, Photography, Lithography, Commercial Art, Institutional Services, Institutional Sewing and Beauty Culture. The vocational program is spread over the three years in which a student attends the school. Year one is roughly equivalent to grade nine, year two to grade ten, and year three to grade eleven. If a student wishes to get a complete high school diploma, he/she must enroll in a regular high school for grade twelve.

Year one is classed as an exploration year. Each student spends approximately six weeks in each of six different vocational areas. Choices are made from among approximately 15 different areas. Year two is classed as a generalization year. Each student spends approximately 12 or more weeks in each of two or three related vocational areas. Year three is classed as a specialization year. Each student spends approximately 20 or more weeks in each

of one or two areas within a vocational cluster.

An example of a vocational program presently being offered is the three-year Automotives program (see Figure 1).

Promotion within the program is based on success (passing) of the previous years' course(s), student aptitude, motivation, attendance and overall record which includes the student's academic program. Of these, the most important is success in the previous years' course(s).

This program is very popular, but because of cost and facility availability only a fraction of those that apply to enter the second and third years of the program can be accommodated. This makes it extremely important to select those students who have the best chance for success.

The Problem

The question arises as to which is the best way to select suitable students.

Research has recently been done at the University of Alberta in the area of Cognitive Processing and Employability (Swann and Snart, 1970). This work is largely based on a cognitive process approach to intelligence testing which is based on simultaneous processing, successive processing and planning factors. Her study showed how cognitive processes were related to performance of various tasks at the Goodwill Vocational Rehabilitation Center. These are perceived to be the three major functions permeating all sorts

PRE-VOCATIONAL	VOCATIONAL	
Exploration	Generalization	Specialization
Year One	Year Two	Year Three
Small Engines 09	Auto Parts 15 and Automotives 15 and Service Station 15	Automotives 25 and Business Foundations 10 or Auto Parts, Merchandising 25 and Business Foundations 10 or Service Station Operation and Management 25 and Business Foundations 10

Figure 1. W.P. Wagner High School Automotives Program

of intellectual activity (Das, Kirby and Jarman, 1979; Ashman, 1978).

Intellectual functions are involved in the automotive program, therefore these processes may play a critical role in student success in the program provided.

Research was done to answer the following questions:

1. Are cognitive processes (simultaneous processing, successive processing and planning) in whole or in part of any predictive value in predicting students' success in the automotive program at W.P. Wagner High School?
2. Are students' scores on school-wide testing in reading comprehension, reading vocabulary and mathematics in whole or in part of any predictive value in predicting student success in the automotive program at W.P. Wagner High School?
3. Is there any relationship(s) between students' scores in tests of cognitive processes and their scores on school-wide reading comprehension, reading vocabulary and mathematics scores?

Delimitations

This study was delimited in the following ways:

1. It was restricted to the Automotives program at W.P. Wagner High School in Edmonton, Alberta;
2. It included only those students who were enrolled in the program during the 1979-1980 school year; and

3. Any results obtained may only apply to the Automotives program at W.P. Wagner High School unless similar results have been found previously.

Assumptions

The following assumptions were made:

1. That the sample is random and representative of the total population in the study;
2. The cognitive processes of coding and planning are basic and underlie all intellectual skills and, to a certain extent, vocational skills, in as much as the latter involve general cognitive skills;
3. That results obtained by the testers who tested the students in years two and three are similar to those which would have been obtained by the investigator who tested the year one students; and
4. The tests used to measure students' achievement in reading comprehension, reading vocabulary and mathematics achievement are valid for the population tested.

Statement of Hypotheses

The following null hypotheses will be tested at the 0.05 level of significance:

1. Cognitive processes (simultaneous processing, successive processing, and planning) in whole or in part are of no predictive value in predicting student success in the

Automotive program at W.P. Wagner High School;

2. Student scores on school-wide testing in reading comprehension, reading vocabulary and mathematics in whole or in part are of no predictive value in predicting student success in the Automotive program at W.P. Wagner High School; and

3. There is no relationship between student scores in cognitive ability tests and their scores on school-wide reading comprehension, reading vocabulary and mathematics achievement scores.

Definitions of Terms

Automotives Student. Any student enrolled in any of the Automotives program courses at W.P. Wagner High School in Edmonton during the 1979-1980 school year.

Year One Student. Any student enrolled in the Small Engines course of the W.P. Wagner automotives program.

Year Two Student. Any student enrolled in the Auto Parts 15, Automotives 15 and Service Station 15 courses at W.P. Wagner High School.

Year Three Student. Any student enrolled in one or more of Automotives 25, Auto Parts 25 and/or Service Station Operation and Management 25 and Business Foundations 10 at W.P. Wagner High School.

Automotives Program. The prescribed courses (Small Engines 09, Auto Parts 15, Automotives 15, Service Station

and Operation 15, Auto Parts 25, Automotives 25, Service Station Operation and Management 25, Business Foundations 10) which are offered to students during their three years of study at W.P. Wagner High School.

Population. All students enrolled in the W.P. Wagner High School Automotives program during the 1979-1980 school year.

Sample. The 100 students in the W.P. Wagner High School automotives program who received complete test batteries in this study.

Marker Tests. Any one or more of Figure Copying, Memory for Designs, Digit Span Forward, Auditory Serial Recall, Trailmaking and Visual Search.

School-Wide Tests. Any one or more of the Sequential Tests of Educational Progress (Reading Comprehension, Reading Vocabulary) and the W.P. Wagner Mathematics Survey Test.

Prediction. The ability to forecast a student's probable success in the W.P. Wagner automotives program based on students' scores on marker tests or school-wide tests.

Success. The passing of courses in the W.P. Wagner High School automotives program.

Logic. The basic principles of reasoning developed by and applicable to any field of knowledge.

Normal Intelligence. Having an average verbal non-verbal I.Q. between 90 to 110 on the Lorge-Thorndike Intelligence Test.

Near Normal Ingelligence. Having an average verbal non-verbal I.Q. between 80 and 100 on the Lorge-Thorndike Intelligence Test.

Significance of Research

Much work has been done linking cognitive abilities and academic success. Much less work has been done on predicting success in vocational training.

Educators have worked on the assumption that if a student is not good academically, then he/she is best suited for vocational training. Because of this, many vocational programs cater to the weaker students often with limited success. The stronger students generally do not get the opportunity to take vocational training.

This research may help in establishing a pattern for predicting which students have the best chance for success in automotives training. If this is so, then we would have a better way of selecting students for this costly program, as well as helping educators develop curricula and teaching methods which are best suited to the type of student one must instruct in a vocational program such as automotives.

CHAPTER II

REVIEW OF THE LITERATURE

This study deals with the relationship between student marks in the W.P. Wagner High School Automotives Program and their scores on selected predictor variables (cognitive abilities, scores on school-wide reading comprehension, reading vocabulary, and mathematics scores). To place these problems in perspective, a review of the literature was made. It has been divided into three parts. The first considers general predictive studies in vocational education; the second considers local predictive studies in vocational education; the third deals with the development of the Simultaneous/Successive Theory for measuring cognitive abilities.

The review is in summarized form except for those parts thought to be especially relevant to this study. A rationale for the research design is developed from the review.

General Predictive Studies in Vocational Education

The foundation of predictive studies in vocational education began in the 1930s. One of the earliest studies (Otis, 1936) tried to predict success in power machine operating. This was followed by studies by Hackman (1940) and Beach (1942). More recently Foote (1960) reported that the Differential Aptitude Test (DAT) and Kuder Persuasive Scale had some merit in predicting success in Auto Mechanics. Carlin (1962) reported that standardized test scores for arithmetic in many instances was the best predictor of success in a vocational high school. Kaltsounis (1965) found the National Aptitude Survey Test as a poor predictor for Auto Shop success.

Over the next decade the General Aptitude Test Battery (GATB) was used as the basis of several studies with varying degrees of success. The Dailey Vocational Test as a vocational predictor was used in some studies also with varying degrees of success. Sandmann (1969) and Cobb (1974) found the GATB to be useful in predicting vocational success. Sandmann reported that GATB was significant in predicting success in several vocational areas including Auto Mechanics (significant at the 0.01 level). Cobb looked at sixteen different predictors and found that GATB (Form G) was the most predictive of the sixteen variables studied in predicting overall vocational student success. Traxler's (1966) study reported that GATB was a more successful

predictor in vocational areas which were more dependent on manual skills than verbal skills although its overall success in prediction of student success was inconclusive. He suggested that it might be of use to counselors in determining which applicants were most similar to those already in the field of study. It was found by Drummond (1975) that GATB was also inconclusive in predicting student success in vocational training in that it did not differentiate as to whether test observations existed prior to or because of vocational training. Goldman (1971) studied GATB as a predictor of success in seven area Vocational-Technical schools in Arkansas and reported that it was not a valid instrument. This observation was shared by Stone (1969) who found the Dailey Vocational Test was a better predictor than GATB in post high school vocational trade, industrial and technical programs. Cox (1968) reported a longitudinal study which followed students from selected private trade, technical and business schools one and five years after graduation and found results of the Dailey Vocational Tests and the Vocational Development Inventory (Form III) to be of no predictive value for post-graduation success.

Following these studies, GATB did not appear in the vocational educational literature until Frazier (1977) reported on a study which looked at factors of aptitude and time related to acquisition of task skills by educationally disadvantaged students. He administered the GATB to a group of these students and found that cognitive aptitudes are

highly correlated with vocational training but of little value in predicting student success in that it could predict success in some phases of courses but not others.

During the 1970s, researchers turned towards a broader range of predictors than they had previously. In a study by Cline (1974) on the relationships of selected factors and student achievement in Auto Mechanics, it was reported that student intelligence was the primary factor influencing student success in Auto Mechanics. He also looked at how teacher experience, teacher's verbal ability, student's age and parent's level of education related to student success in Auto Mechanics. Ludeman (1976) reported that non-vocational students were better in areas of higher mathematics concepts and that vocational students were higher in the practical application of mathematics skills. Sienkilewski (1977) was unsuccessful in developing a multi-variate formula for predicting success and achievement of vocational electrical/electronics students. He used the Iowa Test of Basic Skills, the Differential Aptitude Test (DAT) and individual grade point averages in English, Social Science and Mathematics as predictors without success.

Atkins (1977) did a study in which he tried to develop a "hands on" instrument to measure entry and exit skills in Auto Mechanics as well as other occupations. He took an Auto Mechanics course which was offered to Special Education students and devised pre and post tests based on the non-cognitive areas of the course. These were small

motor movement, large motor movement, measurement, language communication, physical strength and word and tool identification. His results were inconclusive.

Steurer (1977) reported a study which was basically cognitive in nature. He was trying to develop a method to screen vocational shop candidates in a correctional institution. He devised a ten-question test (two factual, two vocabulary definition, six comprehension beyond the factual) based on the first chapter of the text book for that particular area. Prospective students were to read the questions, read the text and then answer the questions in their own words. Out of eleven prospective students he predicted that nine would be successful (based on a test score of 70 percent or better) and found that the nine predicted to be successful were indeed successful. These results, however, could not be extrapolated to other populations because of the nature and confinement of the subjects.

Koscierzynski (1979) was successful in developing a theoretical model that could be used to predict the relationship between educational cognitive styles and achievement in Auto Mechanics.

Sayler (1979) did a study to identify student characteristics which are predictive of student success in high school Auto Mechanics. He used intelligence, age, mathematics achievement, attendance, grade point averages, Differential Aptitude Test (mechanical reasoning subtest), Differential Aptitude Test (space relations subtest) as well

as the counselor's prediction of success and found that all the above predictors together accounted for only 13.3 percent of the variance and were therefore not significant in predicting success in Auto Mechanics.

Predictive Studies at the University of Alberta in Vocational Education

Villagonzalo (1970), Ward (1974) and Lee (1974) reported on studies predicting student success in technology programs at the Northern Alberta Institute of Technology (NAIT) in Edmonton, Alberta, Canada. NAIT is a post-secondary technical school offering several programs in many different disciplines. In addition to apprenticeship programs, certificate and diploma programs are offered.

Villagonzalo's study investigated whether a combination of nineteen predictor variables could differentiate between nine training groups of graduates from NAIT. Analysis was carried out to determine whether nineteen predictors could differentiate between two outcome categories and showed that it was not possible to differentiate between graduates and non-graduates. The nineteen predictor variables could, however, be used to develop a workable prediction scheme for purposes of counseling in a technological institute.

Ward's study investigated the possibility of using the high school record and standardized test scores as predictors for success in the Electronic Technology program at

NAIT. In particular, it studied the influence of the entrance requirements and the kinds of high school preparation on success in the program, the entrance requirements being a high school diploma or its equivalent with minimum standings in Mathematics and Science. Results of his study showed that:

1. It was possible to predict the graduating average of vocational and academic students in the Electronic Technology program on the basis of high school Mathematics, Physics, and average, but it was not possible to make predictions for pretechnology students or for students in general on this basis.
2. Prediction was improved when standardized test scores in Numerical Ability and Verbal Reasoning from the Differential Aptitude test as well as the high school record were used as predictor variables. It was possible to predict the graduating average of pretechnology, vocational, and academic students in the program either separately or jointly with the use of appropriate five-predictor equations.

Lee's study looked at high school Electricity and other related factors influencing the prediction of success in the NAIT two-year electronics program. More specifically his study was concerned with the influence of high school Electronics and Electricity on performance in each of the two years of the technology program, the determination of the best single predictor for success in each of the two

years and the establishment of prediction equations for each year using the best combination of predictor variables from the high school record and the two Differential Aptitude tests. He found that the best predictors were the grade XII math average and Departmental average.

Development of the Simultaneous/Successive Process Theory

The Soviet psychologist Luria's (1966) work with brain damaged patients (left hemisphere brain damage) laid the foundation of the simultaneous/successive processing theory.

Simultaneous processing is utilized when a person brings information together in the form of a Gestalt. An example of this is seeing the relationship between variables.

Successive processing is utilized to formulate or produce some series of events.

The planning facter involves the utilization of information in goal directed behavior.

Luria observed that:

1. Occipital-parietal lesions resulted in disturbances in the simultaneous processing of stimuli;
2. Fronto-temporal lesions resulted in disturbances in successive planning; and
3. The pre-frontal area was probably involved in planning.

He suggested that the simultaneous mode may prove to be more efficient for certain tasks than the successive,

although he did not propose an overall hierarchical arrangement for the two modes of processing information. Both modes are influential in direct perception, memory and more complex functions.

Factor analytic studies (Das, 1972, 1973; Das, Kirby and Jarman, 1975; Das and Molloy, 1975) have indicated the stability of the coding factors over different cultural and age groups, achievement levels, and different socio-economic levels. Ashman (1978) extended the information-integration theory in his dissertation by emphasizing the planning factor and describing its relationship to simultaneous and successive synthesis. His work initiated the idea that types of cognitive processing could have some significant bearing upon potential for employment among developmentally handicapped young adults.

Snart (1979) carried out a joint research project between the Goodwill Vocational Rehabilitation Training Center in Edmonton and the Center for the Study of Mental Retardation (University of Alberta) using six marker tests based on the information-integration theory. These are:

1. Figure Copying 2. Memory for Designs	markers tests for simultaneous processing
3. Digit Span Forward 4. Auditory Serial Recall	marker tests for successive processing
5. Trailmaking 6. Visual Search	marker tests for planning factor

She then correlated the results of these tests with the results of the Jewish Employment and Vocational Services (JEVS) and the Vocational Information and Evaluation Work Samples (VIEWS) test batteries. Both JEVS and VIEWS batteries were developed by the Vocational Research Institute, a division of the Jewish Employment and Vocational Services (JEVS) in Philadelphia. She found that, for specific samples, it appeared that either one type of coding, coding plus planning, or both types of coding or planning may influence successful performance on a task, depending on the complexity of that task.

The review of the literature, especially the studies reported by Carlin (1962), Frazier (1977), Cline (1974), Ludeman (1976) and Lee (1974) seemed to indicate that cognitive ability might play a significant part in predicting student success in a vocational area such as automotives. H.R. Ziel (1974) suggested that industrial arts (which can lead to vocational training) be used as a "tool" to reinforce the academic areas (mathematics, science, language, and social studies). This review seemed to reinforce his concept, although the primary focus was on vocational training rather than industrial arts. My own experience as a vocational teacher led me to believe that the better students were academically superior to the weaker students in that they tended often to progress more quickly and develop competencies which weaker students often had trouble achieving. This seemed to show up most when troubleshooting and

more complex service operations were required.

Several studies cited used I.Q. as a variable. The studies reported by Das (1972, 1973), Das and Molloy (1975), Das, Kirby and Jarman (1975), Ashman (1978) and Snart (1979) represented a newer approach to intelligence which I felt had merit. I felt that it would be reasonable to see if the cognitive abilities approach to intelligence that they had proposed had merit in predicting student success in automotives and designed this investigation to test its merit in this situation.

CHAPTER III

STRUCTURE OF THE INVESTIGATION

This study sought to answer three questions:

1. Are cognitive abilities (simultaneous processing, successive processing, and planning) in whole or in part factors in predicting student achievement in automotives?
2. Are students' school-wide reading comprehension, reading vocabulary and mathematics test scores in whole or in part factors in predicting student achievement in automotives?
3. Are there any significant relationships between students' cognitive abilities and their scores on school-wide reading comprehension, reading vocabulary and mathematics scores?

The structure of the investigation is given below. It describes the population and sample, the instruments, experimental methods and methods of analysis.

Population and Sample

The population was all students who were enrolled in any one or more of the Automotives courses offered at W.P. Wagner High School in Edmonton, Alberta during the period of

time from September, 1979 to June, 1980. These students were all male with the exception of one female. The total population consisted of 363 students. Of these, 288 were from year one of the program (24 classes averaging 12 students each). There were 45 year-two students (three classes averaging 15 students each) and 30 year-three students (three classes averaging 10 students each).

Each student in year one of the Automotives program is only in that program for one-half day for a period of approximately six weeks. There are two teachers for these students, one being the investigator. Each teacher teaches one group of 12 each morning for the six weeks, and another group of 12 each afternoon for the six weeks. Every six weeks, each teacher teaches two new groups of students. During the course of the school year, each will teach 12 classes averaging 12 students each.

The school administration arbitrarily assigns students to a class, and arbitrarily assigns classes to the two teachers. Since all these classes are arbitrary, it was felt that a sample of 25 percent of the year one population would be adequate and reasonable. The investigator administered the battery to one-half of his classes, that is, the six classes he had in the period from mid October, 1979 to the middle of March, 1980. The cognitive test battery was administered over the six weeks that the investigator had each class. The reason for this was that the author had to do this testing during the normal time these students were

in class and were receiving normal instruction. The complete battery requires approximately one-half hour per student to complete, and it was never possible to devote this much class time to a particular student. The testing had to be done whenever time and situation permitted.

Out of a possible number of 72 students, two students refused to take part in the study. Of the remaining 70 students, seven were either absent during the times when it was possible to do the testing, or quit school during the testing period. Since it was felt most reasonable that only those students completing the entire cognitive battery be included in the study, the first year sample totalled 63.

The testing of the year two and year three students posed a very large problem. It was possible to do the testing only during class time. The investigator could not do this testing because he was always with his own class. The investigator applied for, and received a research grant from the Edmonton Public School Board to hire two Graduate students to do this testing. These people were both certified teachers who were enrolled in Master's programs in Educational Psychology and had interests in the testing and evaluation area. They were trained to administer the cognitive test battery by the investigator. When the training was over, the investigator had these testers administer the battery to ten students who were in the year one sample. The students' test results obtained by the investigator and those obtained in the retesting by the testers were carefully

compared to ensure that there would be no tester bias introduced into the study. When the investigator was satisfied that this indeed was the case, the study proceeded with the testers completing the battery with the second and third year students.

The year-two population (45) and the year-three population (30) were small compared to the year-one population (288). It was felt that it would be reasonable to test as many of these students as possible since all automotive students would be primarily treated as a single group in this study.

The testers were available only one-half day per week and came to test once a week during the months of April and May, 1980. During this period some students were either beginning, ending, or taking part in work study out of the school; some were absent when the testers were available; and, a few quit school for employment during this period.

Out of the 45 year-two students, it was possible to administer partial batteries to 39 students and complete batteries to only 21 students. These became the year-two sample.

Out of the 30 year-three students, it was possible to administer partial batteries to 22 students and complete batteries to 16 students. These became the year-three sample.

The sample then consisted of the 100 students who

received complete cognitive test batteries. This consisted of 63 year-one, 21 year-two, and 16 year-three students.

The school-wide testing in reading comprehension, reading vocabulary and mathematics was carried out by the departments concerned in June, 1980. The author obtained these results for the students who were in the sample from department records. As will be seen in Table 1, these results were not available for all students in the sample. There are several reasons for this:

1. Some students had early leave for employment at the beginning of June, 1980;
2. Some students had quit school by that time;
3. Some students were absent during the testing period; and
4. A few students refused to cooperate on these tests.

The population, sample and sub-sample are summarized in Table 1.

Instruments

The instruments used are divided into two sections. The first section describes the instruments used to determine students' cognitive ability (cognitive tests) and those used to measure reading comprehension, reading vocabulary and mathematics achievement (school-wide tests). Samples of these instruments appear in the Appendix section.

Table 1

Population, Sample and Sub-Samples Used in This Prediction Study

	Population of Class	Sample of Students Completing One or More Cognitive Tests	Sample of Students Completing All Six Cognitive Tests	Reading Comprehension Test	Reading Vocabulary Test	Math Inventory Test
Year 1	288	70	63	53	53	52
Year 2	45	39	21	21	20	18
Year 3	30	22	16	12	12	7
Totals	363	131	100	86	85	77

Cognitive Tests

As mentioned before, the cognitive tests refer to the battery of tasks which have been used to measure simultaneous and successive processing and planning.

Swann and Snart (1979) used this battery to examine cognitive processes underlying specific work samples as administered to a population of emotionally, intellectually, physically or socially handicapped adult subjects during their vocational assessment program at the Goodwill Rehabilitation Services of Alberta. Ashman (1978) used this battery on normal grade VIII students in Edmonton to study the relationship between planning and simultaneous and successive processing. Das (1972) used this battery on non-retarded and retarded elementary children in Edmonton to determine patterns of cognitive ability.

Table 2 summarizes how the W.P. Wagner automotive students compare to other samples with regards to their performance on some of these cognitive tests.

Table 2 seems to indicate that W.P. Wagner automotive students are reasonably comparable to these populations on these marker tests. Data for other marker tests was not available due to differences in experimental design.

Memory for Designs

Graham and Kendall (1960) designed this task and it has been used by Das *et al.* as a marker test for simultaneous processing. Each of the 15 designs is presented on

Table 2

Means and Standard Deviations for Three Marker Tests for Normal Grade Eight Students, Normal Adults and W.P. Wagner Automotives Students

Marker Test	*Normal Grade Eight Males		**Normal Adults		W.P. Wagner Automotives Students	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Figure Copying	15.12	5.12	16.38	11.52	12.03	4.19
Digit Span Forward	6.58	1.20	7.08	1.59	6.31	1.30
Auditory Serial Recall	53.48	14.34	59.89	11.52	62.91	9.19
	N = 52		N = 66		N = 100	

* Ashman, pp. 56, 60.
**Ashman, p. 82.

a card to the subject for five seconds, and subjects attempt to remember the designs and then reproduce them on paper. each design is scored either 0, 1, 2, or 3 for errors (3 being poor), according to the maintenance of relations and proportions. The designs appear in Appendix E.

Figure Copying

Another task used to indicate simultaneous processing, Figure-Copying, was originally developed by the Gesell Institute (Ilg and Ames, 1964). Booklets are designed for the task so that 15 figures are presented, one at a time, with a space provided beneath each where the subject copies the design. Each drawing is scored as 0, 1 or 2 according to the maintenance of geometric relations and proportions. Alterations to the original test have been made with the deletion of some of the easiest original items, and addition of more complex items as in Ashman's (1978) study. The figures and the guidelines for administering and scoring appear in Appendix D.

Auditory Serial Recall

This marker test for successive processing was revised from its original format by Ashman (1978). The task consists of 16 lists of words (eight paradigmatically similar and eight unrelated) beginning with a list of four words and progressing up to seven word lists. Each series of words is read to the subject at the rate of approximately one word per second, and the subject repeats as

many of the words as are remembered. The score consists of the number of words recalled in the correct serial order. Appendix F contains the word list used in this study.

Digit Span - Forward

This task, used as a marker for successive processing was abstracted directly from the Wecholer Intelligence Scale for Children (1974) and consists of number series (see Appendix G) from two to nine digits in length. Each series is read to the subject at the rate of about one digit per second, and subjects try to repeat the series in the correct order. Two attempts are possible at each series level, and the score is the highest series at which a subject repeats one trial correctly.

Trail Making

An original part of the Army Individual Test of General Mental Ability (1944), this test was adopted by Armitage (1946), Reitan (1955), and Spreen and Geddes (1969). This test was reported by Armitage to measure planning, the ability to see a double relationship, and to shift from one stimulus sequence to another. The task is divided into parts A and B; in part A the subject connects encircled numbers, distributed randomly over the page, in the correct order; in part B letters and numbers are used, the subject drawing lines alternating between letters and numbers in increasing sequences (e.g. 1-A, 2-B, 3-C, etc.). Total elapsed time for the completion of parts A and B is used as

the score. This test and guidelines for its administration are found in Appendix C.

Visual Search Task

This task was also used as a measure of planning ability, and was originally used by Teuber *et al.* (1949). Sixteen overhead viewing transparencies are used in a viewing apparatus which permits accurate timing. Each transparency contains a field of figures, numbers, or letters, and subjects are required to find a target item, presented in a circle in the centre of the field, and point to its location in the field. The transparencies range in difficulty, and both search times (ST) and reaction time (RT) are recorded. Average ST and RT over the 16 trials constitute the subjects' scores. A description of the apparatus, guidelines for administration and examples of fields used appears in Appendix B.

School-Wide Tests

The reading comprehension and reading vocabulary tests were a part of the Sequential Tests of Educational Progress STEP III. These tests were copyrighted in 1979 by Educational Testing Service, and published by the Addison-Wesley Publishing Company. STEP III are basically power tests (depend upon knowledge of subject matter and not speed) using basic measures of reading and mathematics and are available for all grades from kindergarten to grade XII. The standardization process was conducted across the United

States during the 1977-1978 school year. Over 500,000 tests were administered during this process. These provided evidence of reliability as well as content, predictive, construct and concurrent validity.

The W.P. Wagner Mathematics Inventory was developed by the original staff of the school. Because of the unique type of student that attends the school, these people found that standardized mathematics tests had little meaning for these students because so many were in the lower percentile ranks that a normal distribution was not exhibited by these students, and so they proceeded to devise their own inventory. This inventory is normed only for W.P. Wagner High School although it has been used by other schools (T.D. Baker and Jasper Place Composite in Edmonton, Alberta) for their trades and services students who most closely resemble W.P. Wagner students. It has been continually used for the past eleven years as a pretest at the beginning of the school year and a post-test at the end to gauge progress made by W.P. Wagner students in basic mathematical skills.

Performance in Automotives (Small Engines mark for year one, and average mark in the Automotives programs for years two and three) is the criterion variable.

The predictor variables are students' scores on each of the cognitive Tests (Figure Copying, Memory for Designs, Digit Span Forward, Auditory Serial Recall, Trailmaking and Visual Search) and each of the school-wide tests (Sequential Tests of Educational Progress - Reading

Comprehension and Reading Vocabulary subtests, and the W.P. Wagner Math Inventory).

All analyses were done on the University of Alberta Computer using standard programs (DESTO2 and FACT20) that were developed by the Division of Educational Research Services (DERS) and were readily available to students and staff.

CHAPTER IV

RESULTS OF STATISTICAL ANALYSES

The results of the statistical analyses are arranged in four parts:

1. Data used in the analysis;
2. Results of Factor Analysis for all students in sample (N = 100);
3. Results of Factor Analysis for year-one students (N = 63); and
4. Results of Correlational Analysis.

Data Used in the Analysis

This data consists of students' scores on the marker tests, school-wide tests, and automotives courses.

To ensure anonymity, each student was assigned an identification number. All year-one students have identification numbers that begin with the digit 1, year-two students have identification numbers that begin with the digit 2, and year-three students have identification numbers that begin with the digit 3.

All students in the sample had complete batteries of marker tests.

There are blank spaces in the criterion variable

grades. This is because students did not take all automotives courses offered and received grades only for those courses taken.

There are some blank spaces in the school-wide test results column because this information was unavailable because of reasons stated previously in Chapter III.

The raw scores on each test for every student are given in Appendix A.

Means and Standard Deviations

The means and standard deviations for the results of the marker tests, automotives course grade and school-wide test grades is given in Table 3.

It must be noted that this study did not look at grades in each automotive course separately but as a whole. Because of this, the mean and standard deviation for the criterion variable was made on the basis of all automotives courses treated as a single entity. This was in keeping with the design of the study.

It must also be noted that in deriving means and standard deviations only those cases who had complete marker test batteries and complete school-wide test results were considered. Because of some of the school-wide test data being unavailable, the means and standard deviations were done on a basis of 72 cases who did have all data available.

Table 3

Means and Standard Deviations

Variable	Mean	S.D.
Visual Search (total search time)	14.894	5.095
Visual Search (total reaction time)	3.014	1.057
Visual Search (mean search time)	1.869	0.740
Visual Search (mean reaction time)	0.378	0.132
Trailmaking	49.600	16.994
Auditory Serial Recall	62.916	9.919
Digit Span Forward	6.306	1.298
Figure Copying	12.028	4.187
Memory for Designs	37.639	5.650
Automotives Course(s) Final Mark	61.433	17.057
Wagner Math Inventory	52.889	17.140
STEP Reading Comprehension	50.250	15.737
STEP Reading Vocabulary	47.902	16.817

Results of Factor Analysis
For All Students in Sample (N = 100)

The first factor analysis was done to determine factor loadings of the marker tests and final marks in automotives, as well as loadings between the various tests. The school-wide test results were not included because of the missing cases. The results in Table 4 are based on a principal components factor analysis using the criterion of extracting factors whose Eigen-values were one or higher. Three factors were obtained. The results reported in Table 4 are the factor loadings following varimax rotation.

The asterisks indicate the significant statistics in this analysis. The first factor has its highest loadings for Visual Search followed by Memory for Designs and Figure Copying. It can be labelled as the Simultaneous Processing factor.

The second factor indicates high loading for Visual Search reaction time and Automotives Course(s) final mark. Since reaction time in Visual Search, as distinct from search time, is an index of execution or movement time, it seems reasonable to assume that speed of execution is a salient feature of competence in Automotives.

The third factor indicated loadings from Trailmaking (marker for planning) and Auditory Serial Recall and Digit Span (markers for successive processing); it could be named as the successive factor.

These results are all significant in helping to

Table 4

Factor Analysis on 10 Variables

	Factor 1	Factor 2	Factor 3
Visual Search (total search time)	0.943*	-0.052	-0.027
Visual Search (total reaction time)	0.020	0.963*	0.058
Visual Search (mean search time)	0.945*	-0.054	-0.029
Visual Search (mean reaction time)	0.028	0.967*	0.033
Trailmaking	0.204	0.095	-0.623*
Auditory Serial Recall	-0.132	-0.055	0.846*
Digit Span	0.006	0.031	0.812*
Figure Copying	-0.450*	-0.270	0.128
Memory for Designs	-0.505*	0.132	0.170
Automotives Course(s) Final Mark	0.242	-0.417*	0.230

Varimax Rotation

Factors Rotated = 3

answer the questions of this study.

Results of Factor Analysis For Year-One Students (N = 63)

The second factor analysis was done to determine factor loadings of the marker tests and final marks in automotives, as well as loadings between the various tests. This analysis was different from the previous one in two respects. Firstly, only year-one students were included. This was done because the previous analysis dealt with three groups of students as a unit rather than as separate entities, even though they took different courses from different instructors. It was felt that it would be reasonable to look at a more homogeneous group from within the sample. Year one was chosen because the number of cases (N = 63) was adequate for factor analysis. Year two (N = 21) and year three (N = 16) were not done separately because the number of cases in each of those groups was too small for meaningful factor analysis. Secondly, two variables used in the first analysis were eliminated (Visual Search - total search time, and Visual Search - total reaction time). These were eliminated because total search time measured the same condition as mean search time; and, total reaction time measured the same condition as mean reaction time. The results in Table 5 are based on a principal components factor analysis with varimax rotation as before. Three factors whose Eigen-values were one or greater were extracted.

Table 5

Factor Analysis on Eight Variables

	Factor 1	Factor 2	Factor 3
Visual Search (mean search time)	-0.107	-0.691*	-0.181
Visual Search (mean reaction time)	-0.008	0.116	0.750*
Trailmaking	-0.485*	-0.345	0.363
Auditory Serial Recall	0.880*	0.203	-0.031
Digit Span Forward	0.888*	-0.102	0.006
Figure Copying	0.089	0.671*	0.005
Memory for Designs	-0.014	0.816*	-0.032
Small Engines Final Mark	0.070	-0.018	-0.802*

Varimax Rotation

Factors Rotated = 3.

The asterisks indicate the significant statistics in this analysis. Results are similar to those in the previous analysis, and fit our expectations better.

The first factor, the successive factor, has loadings from Trailmaking (marker for planning) and Auditory Serial Recall and Digit Span Forward (markers for successive processing). The successive factor tasks have much higher loadings here.

The second factor has its highest loading from Memory for Designs followed by Visual Search - mean search time (markers for planning) and Figure Copying. This result was similar to what was obtained in the previous factor analysis except that it is better defined as a simultaneous factor.

The third factor rotated indicated that there was high loading between Visual Search - mean reaction time and Small Engines final mark. Again, this result was similar to that obtained in the previous factor analysis.

The similarities between the results from the two factors analyses indicate that the groups from each analysis are similar and that results for either group can be extrapolated from the results of the other group. It further indicates that the marks obtained in year one of the Automotives program are indicative of the marks in the second and third years of the program and also that Visual Search - mean reaction time is also a good predictor.

On the basis of the factor analyses, one would

expect that there are significant correlations between:

1. Visual Search (mean reaction time) and Automotives Course(s) grade;
2. Trailmaking and Auditory Serial Recall;
3. Trailmaking and Digit Span Forward;
4. Auditory Serial Recall and Digit Span Forward;
5. Visual Search (mean search time) and Figure Copying;
6. Visual Search (mean search time) and Memory for Designs;
7. Figure Copying and Memory for Designs.

These were checked by referring to the table of intercorrelations.

Results of Correlational Analysis

The correlational analysis was done on 13 variables. For the ten variables that were used for the factor analyses the total sample (N = 100) was used. For the three additional variables (STEP Reading Comprehension, STEP Reading Vocabulary, W.P. Wagner Math Inventory), the 72 who completed all the school-wide tests were used. Any student who missed any one or more of the school-wide tests was not included in the correlations for those tests but were used in all the other correlations.

All predictions made on the basis of the factor analysis were confirmed by the correlational analysis. These results are summarized in Table 7.

Table 6a

Significant Results of Correlational Analysis

	Variable	Visual Search (Total S.T.)	Visual Search (Total R.T.)	Visual Search (Mean S.T.)	Visual Search (Mean R.T.)	Trailmaking
	Visual Search (Total search time)					0.253*
	Visual Search (Total reaction time)					
	Visual Search (Mean search time)					0.257**
N = 100	Visual Search (Mean reaction time)					
	Trailmaking	0.253*		0.257**		
	Auditory Serial Recall	-0.382**		-0.381**		-0.418**
	Digit Span Forward					-0.247*
	Figure Copying	-0.235*		-0.241*		
	Memory for Designs	-0.344**		-0.354**		
	Automotives Course(s) grade		-0.233*		-0.233*	-0.215*
	W.P. Wagner Math Inventory	-0.304**		-0.300*		-0.300*
N = 72	STEP Reading Comprehension	-0.320**		-0.325**		
	STEP Reading Vocabulary					

*Significant at 0.05 level; Critical r = 0.232 for N = 72; Critical r = 0.195 for N = 100.

**Significant at 0.01 level; Critical r = 0.302 for N = 72; Critical r = 0.254 for N = 100.

Table 6b

Significant Results of Correlational Analysis

Variable	A.S. Recall	Digit Span	Figure Copying	Memory for Designs	Auto.Grade	W.P. Wagner Math Inventory	STEP Reading Comprehension	STEP Reading Vocabulary
Visual Search (Total S.T.)	-0.382**		-0.235*	-0.344**		-0.304**	-0.320**	
Visual Search (Total R.T.)					-0.234*			
Visual Search (Mean S.T.)	-0.381**		-0.241*	-0.354**		-0.300**	-0.320**	
Visual Search (Mean R.T.)					-0.233*			
Trailmaking	-0.418**	-0.247*				-0.300**		
Auditory Serial Recall		0.547**				0.253*	0.291**	0.369**
Digit Span Forward	0.547**						0.268**	0.237*
Figure Copying				0.306**		0.331*		
Memory for Designs			0.306**				0.265**	
Automotives Course(s) Grade						0.327**		

W.P. Wagner Math Inventory	0.253*		0.331**		0.327**		0.363**	0.316**
STEP Reading Comprehension	0.291*	0.268*		0.265**		0.363**		0.592**
STEP Reading Vocabulary	0.369**	0.237*				0.316**	0.592**	

*Significant at 0.05 level.

**Significant at 0.01 level.

Table 7

Predicted and Observed Correlations

Predicted Correlations	Observed Correlations
1. Visual Search (mean reaction time) and Automotives Course(s) grade	-0.233*
2. Trailmaking and Auditory Serial Recall	-0.418**
3. Trailmaking and Digit Span Forward	-0.247*
4. Auditory Serial Recall and Digit Span Forward	0.547**
5. Visual Search (mean search time) and Figure Copying	-0.241*
6. Visual Search (mean search time) and Memory for Designs	-0.354**
7. Figure Copying and Memory for Designs	0.306*

*Significant at 0.05 level.
**Significant at 0.01 level.

In addition to the above, other significant correlations were obtained. These were: Visual Search (mean search time) and W.P. Wagner Math Inventory (-0.304), STEP Reading Comprehension (-0.320); Trailmaking and W.P. Wagner Math Invetory (-0.300); Auditory Serial Recall and W.P. Wagner Math Inventory (0.253), STEP Reading Comprehension (0.291), STEP Reading Vocabulary (0.369); Digit Span and STEP Reading Comprehension (0.268), STEP Reading Vocabulary (0.237); Memory for Designs and STEP Reading Comprehension (0.265); W.P. Wagner Math Inventory and STEP Reading Comprehension (0.363), STEP Reading Vocabulary (0.316); STEP Reading Comprehension and STEP Reading Vocabulary (0.592).

One other correlation that was extremely important to this study is the correlation obtained between the W.P. Wagner Math Inventory and Automotives Course(s) Grade (0.327).

On the basis of the factor and correlational analysis it appears that two tests may be of use in predicting success in the W.P. Wagner Automotives Program. These are Visual Search (mean reaction time) and the W.P. Wagner Math Inventory. It also appears that the students' marks in the first year of the course are very good predictors of success in subsequent years of the program.

The other significant findings reported in this study are not being stressed only because they are peripheral to the focus of this study. They are very significant in other areas of research and will be further discussed in Chapter V.

CHAPTER V

DISCUSSION

The main idea behind this study was to determine a possible method, other than that which was presently in use, for predicting which students might have the best chance for success in the W.P. Wagner Automotives program. This was of importance to the school because of the high attrition rate in the program in the time interval between the beginning of the second year and graduation at the end of year three. This resulted in an economic and facilities utilization problem in that funds for staff and facilities are allocated on the basis of 45 students each in years two and three, yet it has been historically common to start with 45 students at the beginning of year two and only 30 at the beginning of year three, as was the case in the population of this study. On the surface one may not see this attrition as an important factor, however upon closer inspection, one realizes that only a 66 2/3 percent return for each educational dollar results in this situation in that the cost of operating the year-three program remains the same whether there are 45, 30 or fewer students.

This attrition rate is by no means unique to W.P. Wagner High School which, in fact, has a low rate compared to other schools of this type.

Attrition is a problem that results from numerous and varied factors many of which schools have little or no control over. One factor that schools have some measure of control over is selection of students into programs. This study showed a high correlation (significant at the 0.01 level) between students' performance on the W.P. Wagner Math Inventory and Automotives grades.

The present selection method for promotion from year one to year two of the automotive program is based on the following factors:

1. The student's marks in year one of the program (Small Engines 09);
2. The student's overall attendance record; and
3. The student's overall record in academic subjects (all subjects of equal importance).

The high correlation between the Math Inventory and Automotives grades suggests that student scores on the Math Inventory be an importantly considered factor in selecting students into year two of the program. This will be done in the 1981-82 school year. Hopefully it may help to lower the attrition rate; however, whether it does not not remains to be seen at this time.

Ziel (1971) suggested the Industrial Arts program should have reinforcing the academic disciplines as one of its major objectives. The high correlation between Math and Automotives obtained in this study tends to lend support to Ziel's work. Industrial Arts differs from Vocational

Education in that Industrial Arts emphasizes general trade skills, and Vocational Education stresses more specific skills (as they are related to specific trades or vocations). Even though Autmotives at W.P. Wagner is more vocationally oriented, rather than Industrial Arts oriented, the high correlation between Math and Automotives supports Ziel's suggestion of the importance of math. Since most students receive Industrial Arts training before entering vocational training, perhaps Industrial Arts is the proper time to reinforce math concepts learned earlier. Ziel suggested that Industrial Arts is a good area in which psychomotor skills can be used as the basis of reinforcing cognitive and affective areas which are being taught in other areas of curricula.

Ward (1974) and Lee (1974) reported that Math was an important factor in predicting success in the Northern Alberta Institute of Technology's post-secondary electronics program. Ward investigated the possibility of using the high school record and standardized test scores as predictors for success. He found that it was possible to predict the graduating average of students in the Electronic Technology program on the basis of high school mathematics, physics and average, but was not able to make good predictions for pre-technology or students in general on this basis. A student graduating from the W.P. Wagner Automotives program would be roughly equivalent to a N.A.I.T. pre-technology student in that both would be generally at the grade XI

level. Lee's study was primarily concerned with the influence of high school Electricity and Electronics on performance at N.A.I.T. He found them to be inferior to high school math as a predictor. It is interesting to note that Ward and Lee both found mathematics to be a significant predictor even thought they studied a different age group and field of study than was reported in this study. Perhaps, as more newer studies are done on predictability of success in different trade or vocational areas, the importance of a good math background might be more clearly defined. The importance of math as a predictor of success in a vocational high school was documented much earlier by Carlin (1962) and by Ludeman (1976) who reported that vocational students were generally better than academic students in the practical application of mathematics skills. His study did not report, however, whether the vocational students in his population were better in the practical application of mathematics skills independent of or because of their vocational training.

This study sought to answer three specific questions in attempting to determine a possible method, other than that which was presently in use, for predicting student success in automotives. These were:

1. Are cognitive abilities (simultaneous processing, successive processing, and planning) in whole or in part factors in predicting student achievement in automotives?
2. Are students' school-wide reading comprehension, reading

vocabulary and mathematics test scores in whole or in part factors predicting student achievement in automotives?

3. Are there any significant relationships between cognitive abilities and their scores on school-wide reading comprehension, reading vocabulary and mathematics scores?

This question was not central to the study, but it was felt that it would be valuable to confirm or add information to the Simultaneous/Successive Process Theory.

In answer to the first question, the results showed a high loading between Visual Search - mean reaction time and mark in automotives. Visual Search is a marker for the planning factor which has both search time and reaction time components, the reaction time component being the significant one in this study. Ashman (1978) described this planning factor in detail as well as showing its relationship to simultaneous and successive processing. The results of this study support his work in defining it as a cognitive factor apart from simultaneous and successive processing.

The significance of reaction time in this study is not surprising in that it has a manual dexterity component and a fair measure of it helps in performing many automotives procedures.

The results also showed high loadings between Auditory Serial Recall and Digit Span Forward (the successive factor) and Figure Copying and Memory for Designs (the simultaneous factor). This added support to the work

of Das (1973, 1973); Das, Kirby and Jarman (1975) and Das and Molloy (1975).

The answers obtained to the second question proved to be the most important in this study. The most important factor in predicting student success in automotives was their performance on the W.P. Wagner math inventory (correlation significant at the 0.01 level). No significant correlations were found between the STEP Reading Vocabulary and Reading Comprehension scores and marks in automotives. The significance of math was not surprising in that basic computational skills and measuring skills are the basis of engine rebuilding which occupies a significant amount of time in the Automotive 15 and 25 programs, and in that logic permeates all troubleshooting and repairing procedures which both proceed in logical, step-wise steps.

In answer to the third question, several significant relationships were found. These were:

1. Planning (Visual Search - search time) and Math;
2. Planning (Visual Search - search time)
Successive Processing (Auditory Serial Recall)
(Digit Span Forward)
Simultaneous Processing (Memory for Designs)
and Reading Comprehension
3. Successive Processing (Auditory Serial Recall)
(Digit Span Forward)
and Reading Vocabulary

Supplementary to these other significant relationships were found. These were:

1. Visual Search and Trailmaking (markers for planning);
2. Digit Span Forward and Auditory Serial Recall (markers for successive processing); and
3. Memory for Designs and Figure Copying (markers for simultaneous processing).

The findings relating to the third question confirmed and added support to the Simultaneous/Successive Process Theory of Cognitive Abilities as reported in previous research by Das (1973, 1973), Das, Kirby and Jarman (1975), Das and Molloy (1975), Ashman (1978) and Swann and Snart (1978).

In summary, the findings most important to this study were:

1. Students' scores on the W.P. Wagner Mathematics Inventory are the best predictor of success in the Automotives program; and
2. Students' scores on the Visual Search - reaction time marker test for the planning factor was the second best predictor of success in the Automotives program.

In general, this study was extremely difficult to complete in that much of the testing was done in regular class time which the researcher was teaching. This meant that the research had to be done while maintaining a teaching-learning environment in a class of 12 students who all needed more individual attention than students in a

regular classroom. It was not able to have a free minute in class over the entire testing period (18 weeks). Needless to say, it left me exhausted! I would recommend that others who might get involved with teaching and research at the same time choose studies that do not require concurrent time-sharing.

Recommendations

1. That the promotional procedures from year one to year two of the automotives program be amended to consider the student's mark on the W.P. Wagner Mathematics Inventory.

2. That students in the second and third year of the automotives program be required to keep up their work in math at an acceptable level. I don't feel that having students complete the Visual Search - reaction time test, even though it is a significant predictor, would be a worthwhile pursuit because it is fairly time consuming with regards to tester's time and would not add enough to the above two recommendations to make it worthwhile.

3. That the significance of math to other vocational areas at W.P. Wagner be investigated.

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APPENDIX A

RAW SCORES ON ALL TESTS

RAW SCORES ON ALL TESTS

STUDENT	IDENTIFICATION NUMBER / MARKER TEST RESULTS: VISUAL SEARCH (TOTAL SEARCH TIME (SECONDS), TOTAL REACTION TIME (SECONDS), MEAN SEARCH TIME (SECONDS), MEAN REACTION TIME (SECONDS)), TRAILMAKING (SECOND), AUDITORY SERIAL RECALL, DIGIT SPAN FOREWARD, FIGURE COPYING, MEMORY FOR DESIGNS	CRITERION VARIABLE GRADES: GRADE - SMALL ENGINES (%), GRADE - AUTO PARTS (%), GRADE - SERVICE STATION OPERATION + MAINTENANCE (%), GRADE - AUTOMOTIVES (%)	SCHOOL-WIDE TEST RESULTS: WAGNER MATH INVENTORY (%), STEP - READING COMPREHENSION (%), STEP - READING VOCABULARY (%)
1	10113.072.331.63.29072.95381342	62	243040
2	10209.216.151.15.77037.86570536	50	566843
3	10315.971.772.07.22044.15461534	62	627430
4	10416.943.242.12.41047.85651642	91	726453
5	10520.182.992.52.37048.45861643	81	566467
6	10619.844.182.48.52056.86061324	80	302223
7	10712.353.601.54.45045.76980829	60	605650
8	10810.163.751.27.47033.57580632	68	427263
9	10934.862.614.36.33062.37491040	81	187470
10	11011.093.441.39.43031.06771137	56	
11	11112.723.891.59.49040.95650731	47	44
12	11207.623.420.95.43028.95751244	93	767253
13	11312.971.831.62.23053.35561338	61	787480
14	11413.262.821.66.35052.25470839	26	
15	11531.822.783.98.35053.14251336	41	323223
16	11616.863.732.11.47039.86371120	59	405030
17	11721.782.542.66.32037.76870941	91	522433
18	11808.563.081.07.39034.37591038	61	8293
19	11910.154.151.27.52041.87061040	66	604627
20	12010.102.161.26.27034.38191443	75	587463
21	12116.432.622.05.33056.16960934	80	24
22	12212.903.381.61.42044.77081142	83	584040
23	12316.402.442.05.31032.67081341	81	746860
24	12430.571.903.82.24035.17391037	58	32
25	12510.442.371.31.30039.38050845	75	546047
26	12612.192.691.52.36049.87061740	57	446057
27	12717.252.812.16.35038.38190636	84	487257
28	12809.685.091.21.64033.47481242	53	485237
29	12909.803.051.23.39037.06771344	32	707457
30	13007.284.460.91.56055.46671444	56	
31	13136.662.504.58.31044.93360525	61	281827
32	13209.243.721.16.47030.47380941	62	545647
33	13310.493.861.31.43047.96771445	51	545040
34	13407.754.270.97.53046.96681945	19	184633
35	13517.242.682.16.34056.16961441	17	
36	13613.533.541.69.44066.07070637	40	445823
37	13718.763.992.35.50093.15250738	29	121417
38	[illegible]	41	[illegible]

YEAR 1

62

39	13911.072.051.38.26039.45660941	33			625060	
40	14014.934.601.87.59041.06361036	30				
41	14117.164.682.15.59045.24651543	45			404443	
42	14207.873.090.98.39056.36261043	22				
43	14310.003.091.25.39039.56230527	69			565670	
44	14408.182.401.02.30036.36141043	73			6040	
45	14510.092.561.26.32046.77261142	31			324267	
46	14615.202.701.90.34054.27581145	32			664453	
47	14710.803.121.35.39046.36871343	67			3630	
48	14814.132.371.77.30072.55250341	78			465853	
49	14914.862.021.86.25063.95360636	78			463247	
50	15015.334.071.92.51091.54951043	76			765247	
51	15113.683.821.71.48052.44850736	60			325457	
52	15209.162.501.15.32053.95351244	48			465823	
53	15314.791.851.85.23045.37361242	67			626263	
54	15410.882.551.36.32032.06261643	83			685850	
55	15511.065.871.36.73059.65441644	50			363813	
56	15613.424.351.68.54061.86571539	75			645043	
57	15716.684.242.34.53102.56070729	20			303663	
58	15816.065.762.01.72037.37371345	53				
59	15907.924.860.99.61048.64540744	25				
60	16026.792.290.85.29033.95971445	75			425443	
61	16115.252.051.91.26055.66671336	40			386247	
62	16215.382.471.92.31055.45451441	63			385050	
63	16310.625.411.33.68036.57382040	48			647090	
64	20118.722.562.54.32074.05871126		54		51545260	
65	20219.942.072.49.26057.05271439	53	70		52283423	
66	20310.511.611.31.20033.07241738	76	65		65603657	
67	20413.262.081.89.26043.06860733	73	60		55622640	
68	20512.472.401.56.30094.56951842	83	65		70565677	
69	20609.491.791.17.22031.07671937		56	65	4334	
70	20713.922.391.74.30041.56871632		55		53442437	
71	20817.222.722.15.34041.05752042	73	59	50	5863	
72	20917.671.952.23.24069.55951340	44			7470	
73	21009.492.681.19.34038.57171742	63	59		45845857	
74	21109.721.671.22.20054.07471138	69			766080	YEAR
75	21221.731.992.72.25034.57581933	68	51		614454	2
76	21315.441.541.93.19052.05971534	82	42		52727467	
77	21417.592.362.76.29045.06151733	62	61		70724040	
78	21517.383.612.17.45054.05051135	54	45		51447063	
79	21615.342.771.92.35046.06701431		61		42563443	
80	21714.631.571.83.20100.04541931	63	64		57824217	
81	21814.281.381.79.17035.07161434	54	35		65703220	
82	21911.612.261.48.28027.07781838		54		82748073	
83	22010.372.261.34.29028.06672039	73	62		85824473	
84	22112.102.121.51.27026.06972141	60	55		70703653	
85	30151.984.086.50.51052.07650729	61				
86	30225.363.123.17.39043.06560624	55			4437	
87	30316.961.962.12.25062.06750832	77			403440	
88	30414.892.681.86.33035.05661335	49				
89	30527.442.403.43.30048.05450631	67			543433	YEAR
90	30612.403.081.55.39044.06570429		59	50	2243	3
91	30717.244.122.16.52044.06351234		58		60705647	
92	30813.309.121.73.62045.07171243		63	53	4840	
93	30911.002.961.36.37037.05251532		53		40424237	
94	31013.043.041.63.38043.07660935		56		60383453	
95	31118.003.852.25.49059.05950528		67		6562	
96	31211.562.121.45:27048.07371536		65	55	6037	
97	[illegible]		61	65		

98	31423.244.443.53.56032.07061342	65 85783640
99	31511.762.881.47.36047.06361430	63 55 6050
100	31615.764.281.97.54040.06781242	59 60 5367

APPENDIX B

VISUAL SEARCH

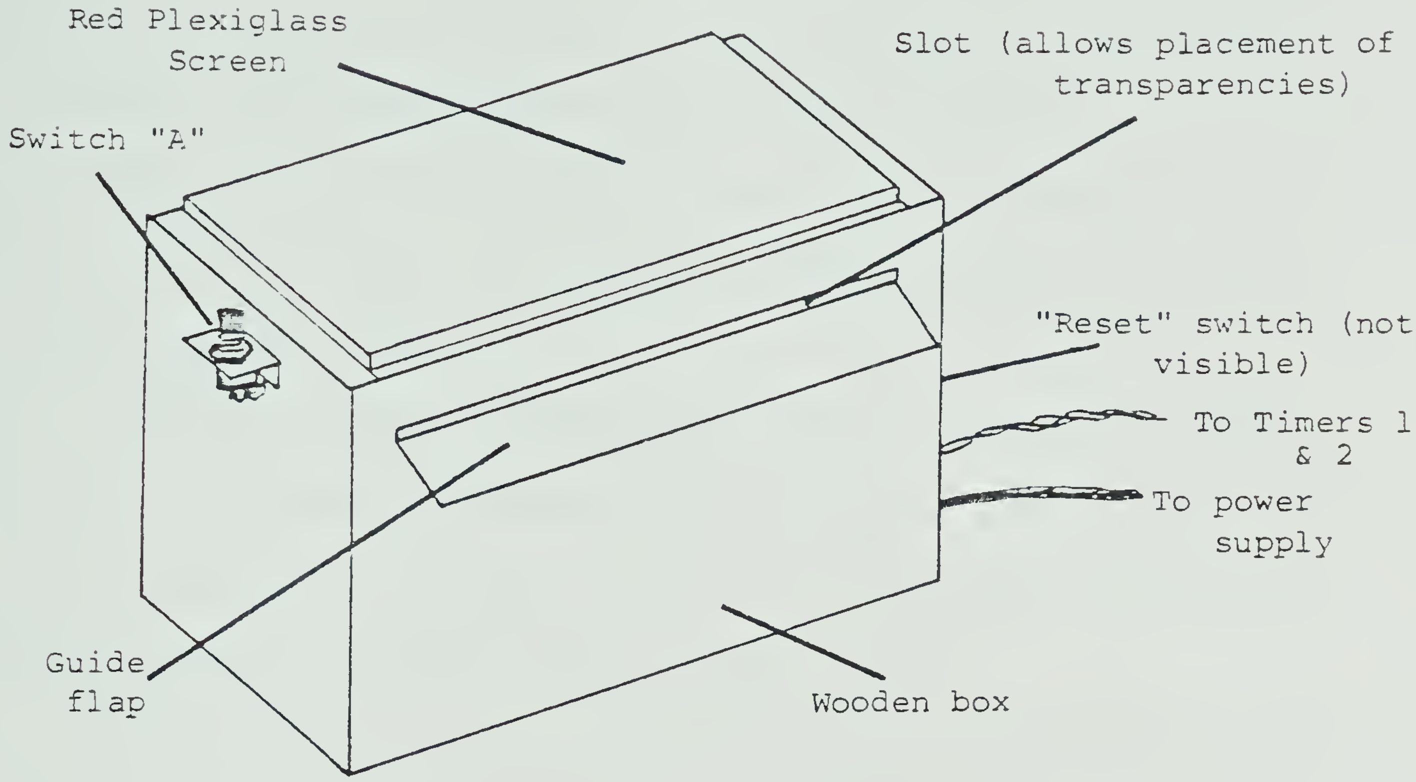
Description of the Visual Search Apparatus

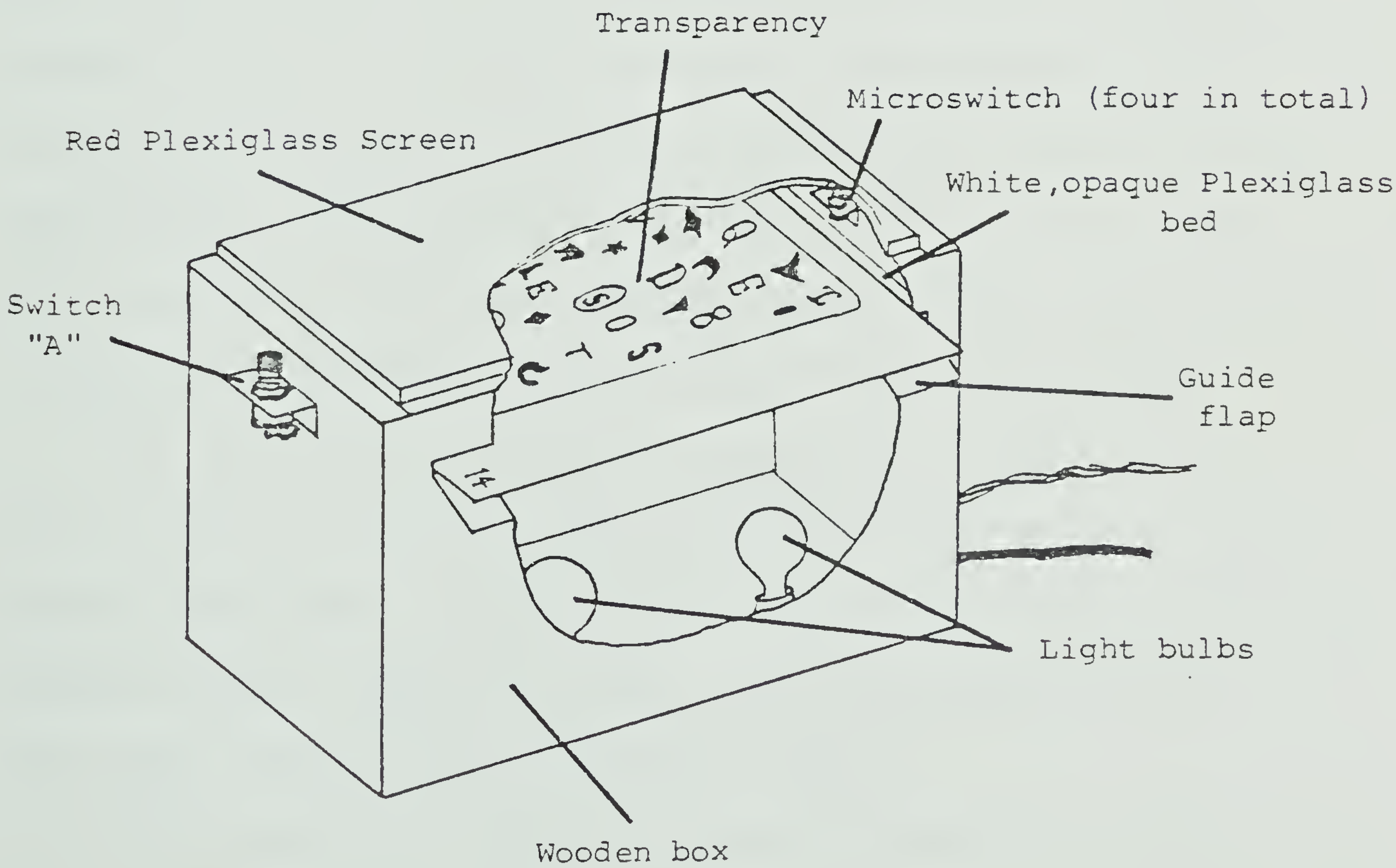
The Visual Search Apparatus consisted of two electronic timers (Lafayette, Model 54417-A) and a search box. This wooden box was 24 centimeters wide, 27 centimeters high, and 36 centimeters long. A red Plexiglass screen was mounted on top, 2 centimeters above a white, opaque Plexiglass bed, and supported by four microswitches and springs. A slot in one side of the box permitted placement of an overhead projector transparency onto the Plexiglass bed.

Depression of switch A on the front side activated timers 1 and 2, and simultaneously switched on lights below the opaque bed, thereby permitting the testee to view the transparency through the red screen. When switch A was released, timer 1 stopped, and a delay kept the lights illuminated for a further one second. This sequence enabled subjects to search the transparency and provided an elapsed search time (taken from depression of switch A and illumination of the transparency, to release of switch A).

Instruction required subjects to locate the duplicate of the standard shape found on the transparency, and to point to it by depressing the red screen. Pressing activated microswitches beneath and stopped timer 2. This provided an elapsed response time (taken from depression of switch A and illumination of the screen, to depression of the screen and switches B). A third switch (located at the back of the box) reset the timers simultaneously.

Diagrams of Visual Search apparatus
Closed and Cut-away views





Testing Procedure

The procedure followed for administration of the Visual Search task was the same for each subject in the sample. All directions were given verbally by the tester and were as follows:

"This is a test of how quickly you can find one pattern in a group of similar ones. We're going to use this box and electronic timers attached to it.

"I have a number of transparancies which I am going to place inside the box and when you turn the light on, you'll be able to see them through the red screen. First I will demonstrate, then you'll have a chance to practice before the test begins.

"This is an example of a transparancy like one that will be used in the test. (Show transparancy to subject and point out circled figure). What you'll have to do is first look at the circled figure, then search the rest of the transparancy for another one that is exactly the same as the one in the circle. Can you show me the figure that is the same as the one in the circle. Point at it with your finger. (Subject points to the right figure). Good, that's right, now let me show you how the box works. First, I will put this transparancy into this slit in the box. (Insert transparancy).

"You can use only one hand for this test. It doesn't matter which one you use. If you are right-handed, use your right and if you are left-handed, use your left. You can either put your free hand in your pocket or behind your back. I'm right handed, so I will demonstrate with it. (Put left hand in pocket).

"The first thing I will do is press this black button down and keep it down. Notice that a red light has come on and you can see the

transparancy that we were looking at. While I am holding down the black button I look at the figure in the circle and then look for the other one that is exactly the same as it. Once I find it I move my finger from the black button and press the glass down right above the figure that is the same as the one in the circle. (Press glass down above that figure). See when I do that, the light goes out. While I was doing that, these two timers were timing how long I held down the black button (point out this timer to subject) and how long it took to move my finger from the black button and push down the glass over the figure that was similar to that in the circle (point out this timer to subject)."

"Now you try it. If subject does it properly say good, you did it right." (If subject made any mistakes correct them now. Things to watch for are subject keeping finger pushed down on black button until he has found the appropriate figure, that subject moves finger as quickly as possible to appropriate spot on glass, and that subject pushes glass down hard enough on the glass on the appropriate spot). Repeat until subject does it properly.

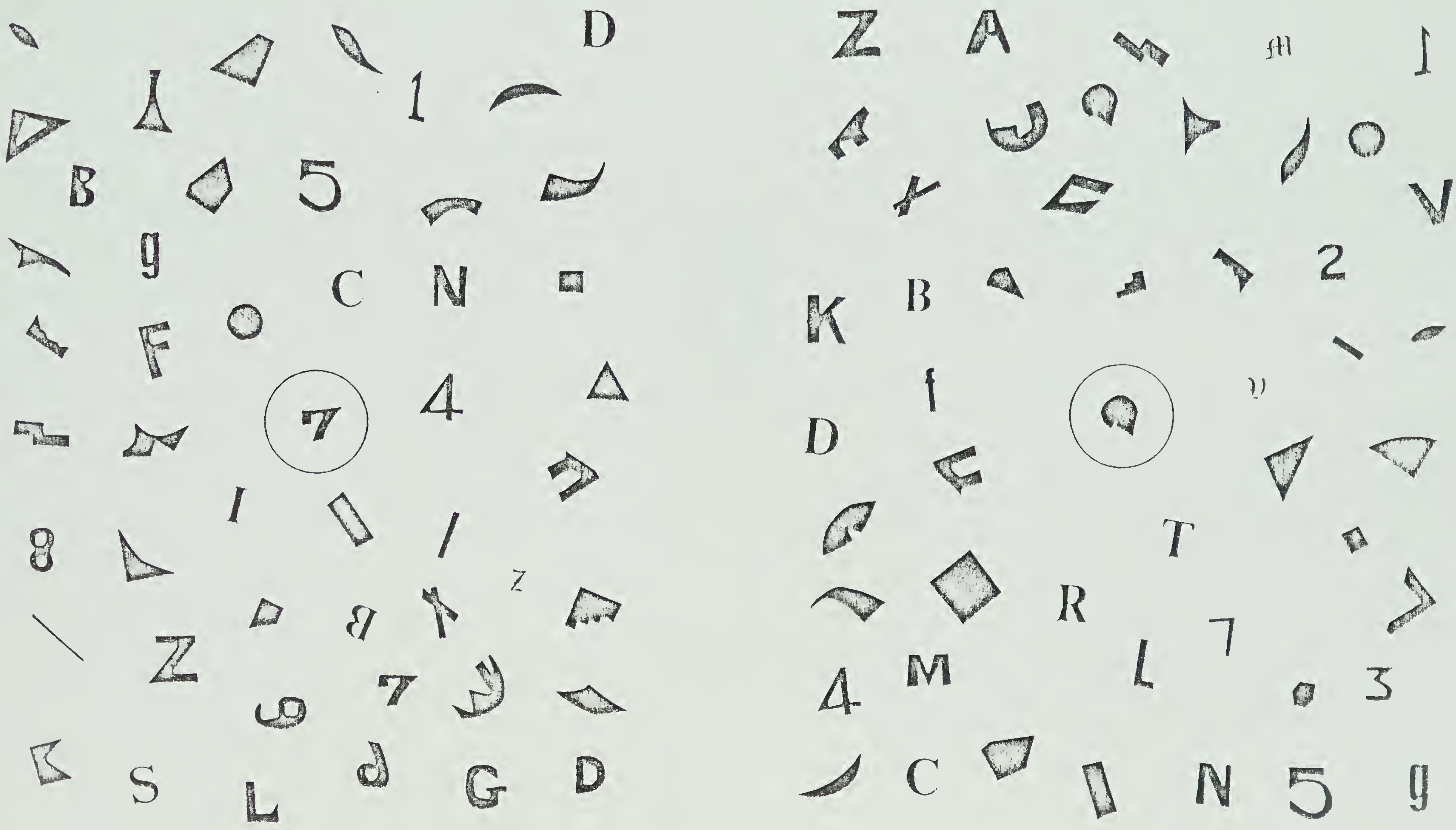
" Now here is another one (insert second practice transparancy into slot) go ahead and try it." Correct any mistakes if there are any.

"Now we're ready to start the test. There will be eight transparancies. You'll do each one of them exactly as you have done the practice ones. " Reset timers and insert first transparancy . "Are you ready. Good. Start. After trial, record search and reaction times and reset timers for next trial. Continue in this manner until all trials are complete.

There are eight transparancies, four being picture-picture and four being number-picture. These are presented alternately.

For scoring all the eight search times are totalled and their average calculated for each subject. The same is done for reaction times.

Two Examples of Visual Search Transparencies (x 0.5)



APPENDIX C

TRAILMAKING

Directions for the Trailmaking Test

Part A.

"In this test all you have to do is to draw lines between the numbers on the page in correct order - from 1 to 2, from 2 to 3, from 3 to 4 and so on, until the end is reached. If you make a mistake, go back and cross it out quickly (you don't have to erase the lines) and then go on in the correct way." Have student do the sample to make sure he does it right. When he has done so say "Good, now I'll give you a similar one that goes from one to fifteen. Do it the same way. Give subject the test, point out where number one is and then say start." Time subject with a stopwatch from the time his pencil touches one to the time it touches fifteen.

Part B:

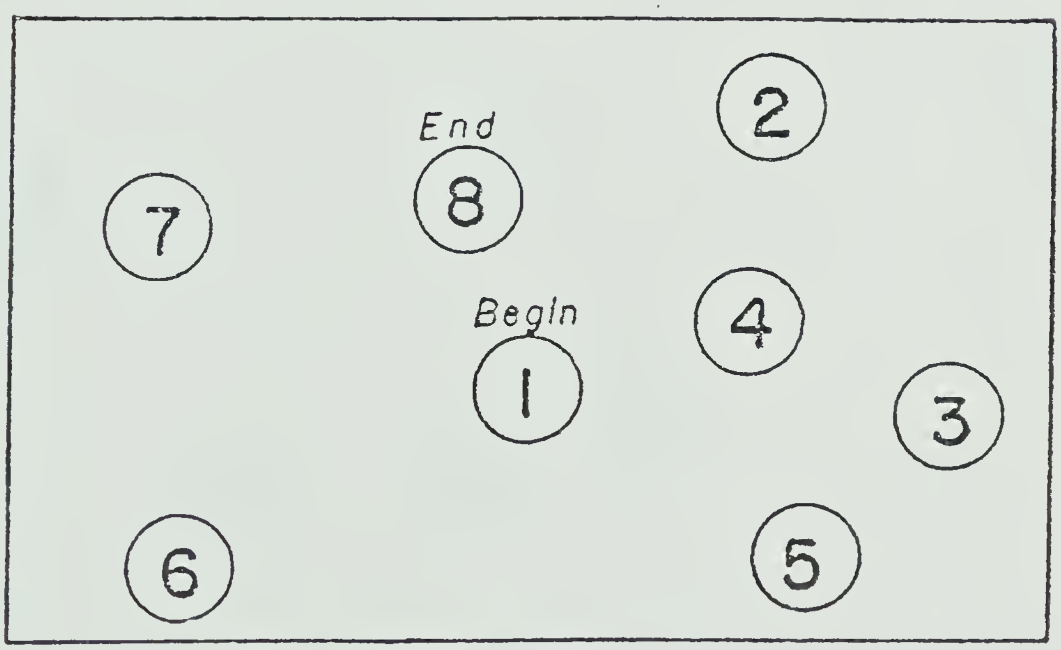
Similar to part A, but this time subject must draw lines in correct order from one to A to 2 to B to 3 to C and so on. Proceed as was done in Part A.

For scoring, simply add up the times in seconds of Part A and Part B to get a total time in seconds for each subject.

INTERMEDIATE FORM
TRAIL MAKING

Part A

SAMPLE

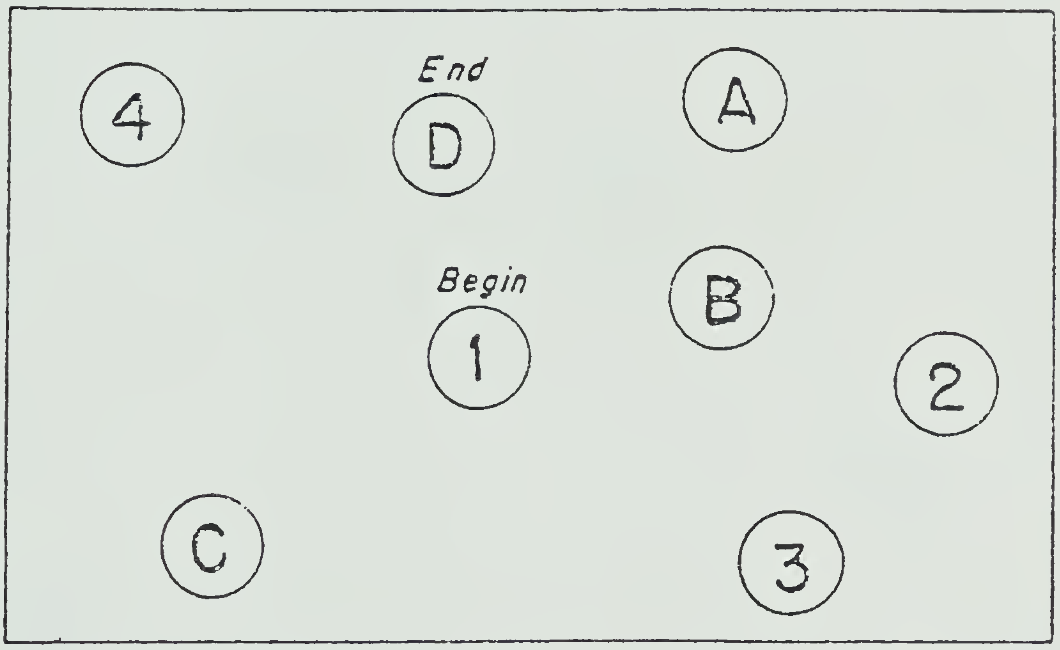


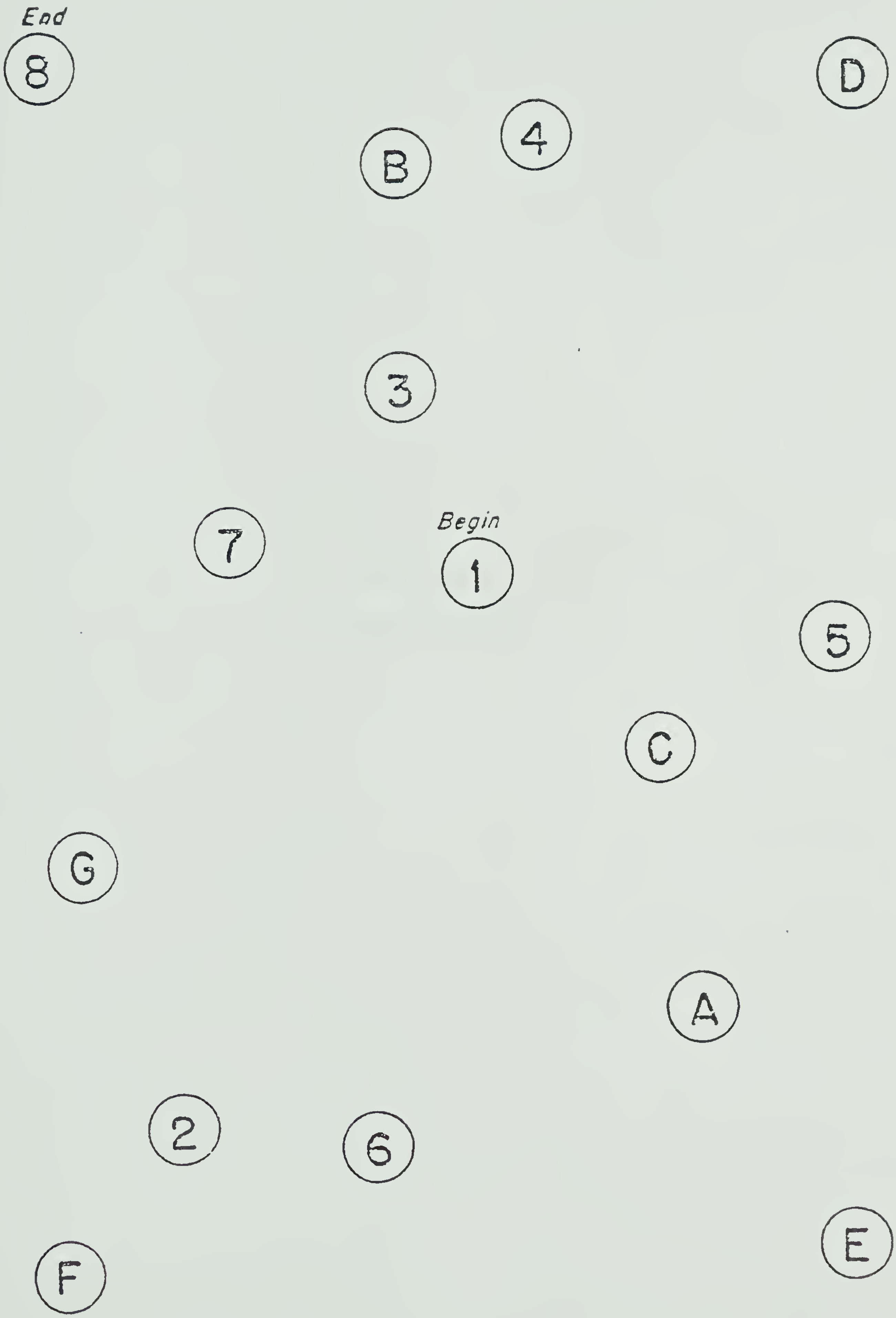

End
15
4
5
13
6
Begin
1
7
14
2
10
8
3
9
11
12

TRAIL MAKING

Part B

SAMPLE



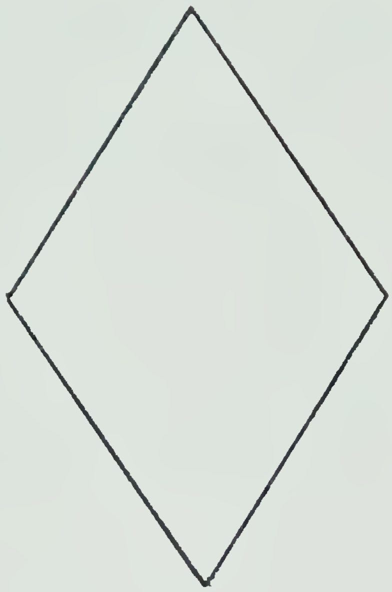

End
8
D
4
B
3
Begin
7
1
5
C
G
A
2
6
E
F

APPENDIX D

FIGURE COPYING

Figure Copying

1.



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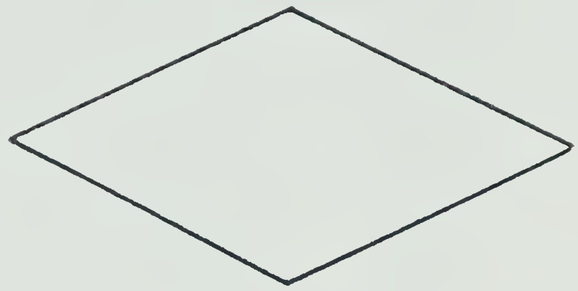

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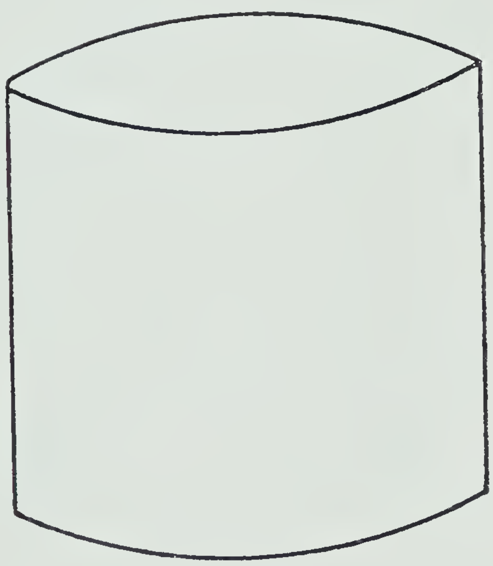

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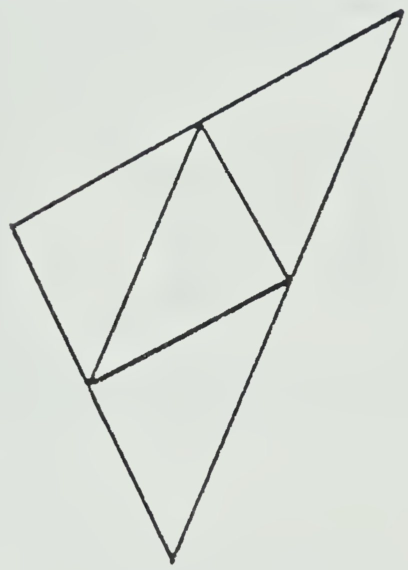

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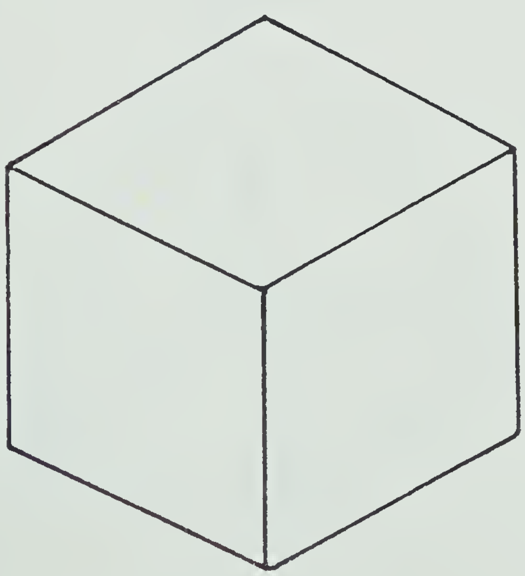

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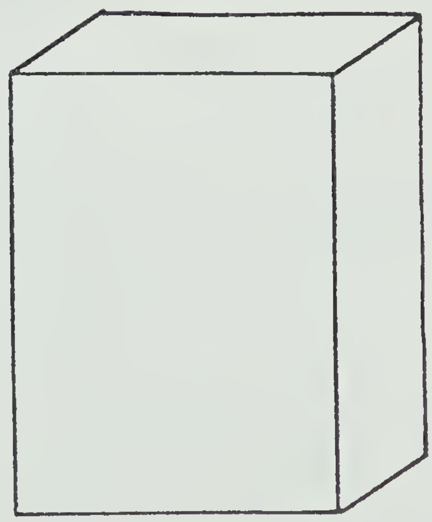

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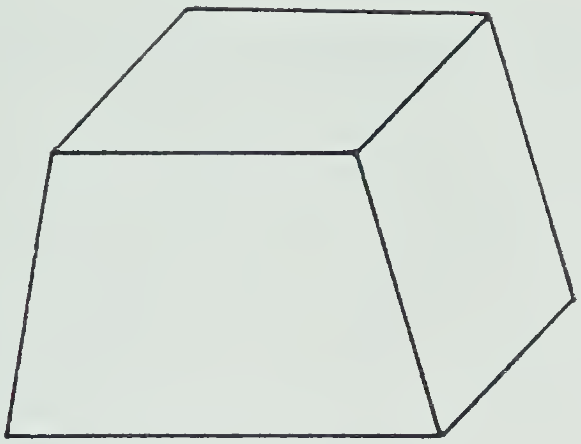

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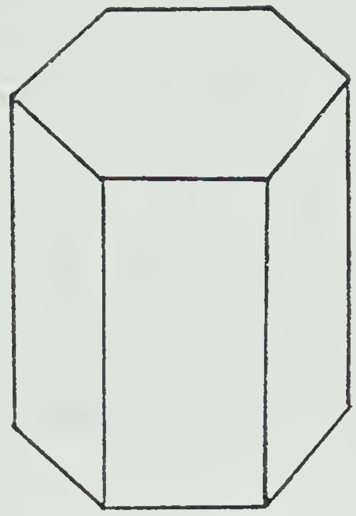

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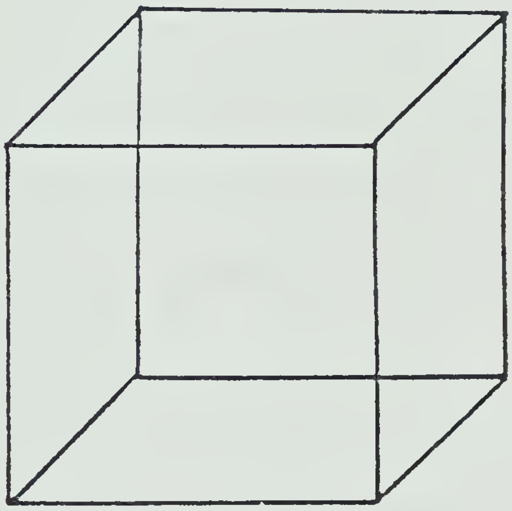

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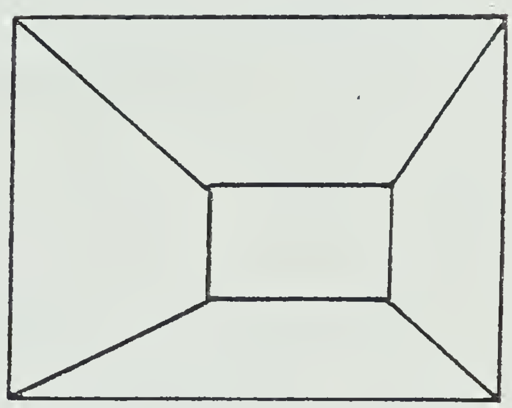
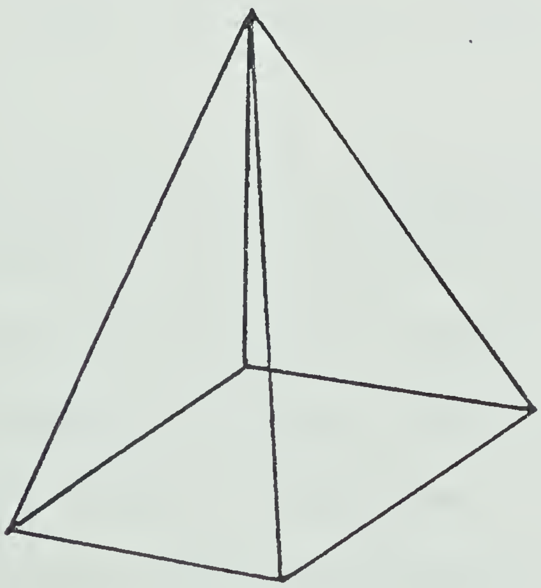
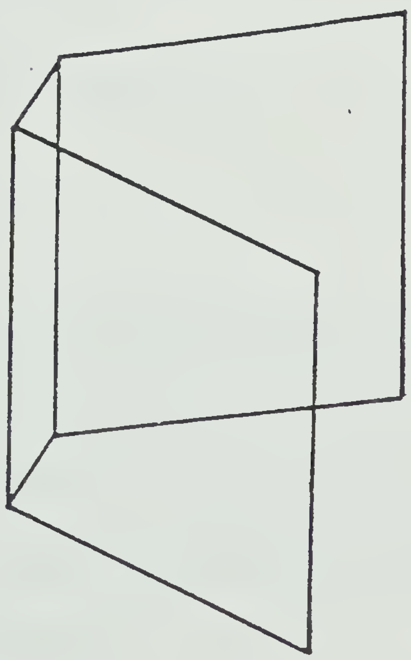


11.



12.



Guidelines for administering and scoring the Figure Copying Test

The subject is required to make an exact, free-hand copy of twelve shapes: a vertical diamond; a horizontal diamond; a cylinder; tilted triangles; a cuboid; an enclosed box; a trapezoid; an octahedron; a necker cube; a tapered box; a pyramid; and a stylized open book. Drawings are scored according to accuracy of shape rather than absolute size. The following principles apply:

For all drawings

1. The drawing must generally maintain the proper perspective
2. Drawings where applicable should be symmetrical
3. Angles should not be rounded
4. Figures should not be rotated
5. Angles should be equal, when applicable
6. Slight bowing or irregularity of lines is permitted
7. Lines should meet approximately, but small gaps or extensions are acceptable
8. When two attempts are made, the worst is scored

Scoring principles for individual figures

Scoring of each figure involves some limited flexibility. In general, some principles are considerd more important than others and are more stringently enforced. In the following table of standards, criteria are given in order of importance. Where the same numbers are given for two criteria, they are considered equally important.

1. Vertical Diamond

   1. No 'kite' shapes

   1. Horizontal opposing corners

   2. Four good corners

   3. Only slight 'dog-ears' allowed

   4. Both acute angles must be 60° or less

2. Horizontal Diamond

   1. No obvious 'kites'

   1. Opposing corners

   2. Four good corners

   2. Horizontal axis between 170° and 190°

   3. Both acute angles 60° or less

3. Cylinder

   1. Diameters should be approximately equal to the height

   2. Diameters of the base and top should be approximately equal

   2. The base and the top lines should be curved

4. Tilted Triangles

   1. Two triangles

   2. Right outer side sloped 100° or more

   3. Two corners of inner triangle clearly touch near medians of outer triangle, and the third must be close.

   3. Left outer angle approximately 90°

5. Cuboid

   1. Proper perspective must be preserved as in the specimen

   2. There should be three approximately equal diamonds

   3. All lines should be approximately equal (i.e. lengths, widths and heights

6. Enclosed Box

   1. Proper perspective must be maintained as in the specimen

   1. Figure must be almost half as high as it is wide

   2. Acute angles of parallelogram should be between 30° and 45°

7. Trapezoid

   1. Proper perspective should be preserved as in the specimen

   2. Parallelograms should have angles of approximately 45°

8. Octahedron

   1. Hexagon should have approximately equal sides

   2. Vertical rectangle should be bounded by two, near equal parallelograms.

   3. Left and right extreme angles of the hexagon should be near 90°

9. Necker Cube

   1. Correct number of parts

   1. Correct orientation

   1. No evidence of confusion

10. Tapered Box

   1. No confusion or distortion

2. Inner form clearly shifted to the right and down

3. Outer form a parallelogram

3. Inner form a horizontal rectangle

11. Pyramid

1. Figure is balanced around the vertical

1. No confusion or distortion

2. Base of figure is a diamond

2. All triangles are near isosles

12. Stylized Open Book

1. Two, mirror-image parallelograms with the acute angles near 75°

1. No confusion or distortion

2. Thin parallelogram should have acute angles between 30° and 45°

According to the guidelines, each figure is scored as 3,2,1, or 0 depending on the accuracy of reproduction. 3 for most accurate and 0 for least accurate. The subject's scores for all figures are totalled up to arrive at his test score. Maximum score is 45. Note that this is not a timed test, but a power test. This test was given as a group test with each figure and a space beside it printed on sheets. The subjects merely had to reproduce each figure, as closely as possible in the space beside each figure.

APPENDIX E

MEMORY FOR DESIGNS

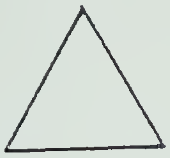
Directions for the Memory For Design Test

This test was done as a group test. Transparancies were made for each of the fifteen designs. Students were given sheets containing fifteen numbered blank spaces and were told that they would be shown a transparancy of a figure for 5 seconds, after which they were to reproduce it in the appropriate space on their sheet. This reproduction was to be done from memory. They were instructed to put their pencils down while they were viewing the transparancy, then when the transparancy was removed, they were to draw the figure, then put their pencils down and wait for the next transparancy. Each transparancy was shown on an overhead projector for 5 seconds and then removed. Students were given as long as necessary to complete their drawings.

This test was scored on the same basis as the Figure Copying Test in Appendix C. Total possible was 45.

Memory-for-Design Test (MFD)

1



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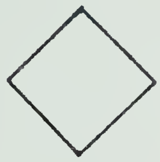
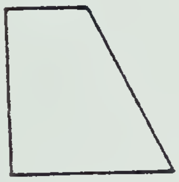


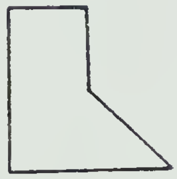
3

4



5

6



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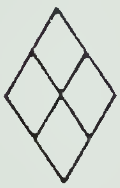

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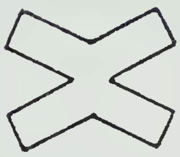
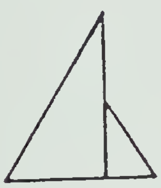


9

10



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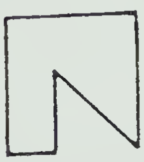
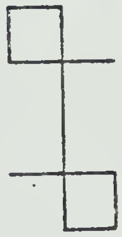
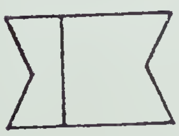


12



13



14

15

APPENDIX F

AUDITORY SERIAL RECALL

Directions for the Auditory Serial Recall Test

Students were told that they would be given some short lists of words which they would be asked to repeat back in order. An example was given. "Repeat the following words in order. Red, Black, White, Blue." Subject repeated list, and corrections, if any were made at this time.

The test consisting of fifteen lists of words was administered individually to each subject.

The score was arrived at by first totally the number of words repeated in the correct order for each list, then totalling the number for all fifteen lists. Total possible was 88.

Auditory Serial Recall

1. tall, long, big, huge
2. high, tall, fat, big
3. day, cow, wall, bar
4. key, few, hot, book
5. book, bar, wall, hot, mat
6. wide, tall, large, huge broad
7. long, big, great, wide, fat
8. few, pen, hot, wall, bar
9. key, hot, cow, pen, wall, book
10. wide, large, big, high, tall, vast
11. long, big, fat, great, large, huge
12. pen, wall, book, key, cow, hot
13. high, fat, huge, wide, long, large, broad
14. day, key, cow, bar, wall, few, hot
15. great, high, tall, long, big, broad, fat
16. cow, day, bar, wall, few, mat, key

APPENDIX G

DIGIT SPAN

Directions for Digit Span

Students were told that they would be given a list of numbers which they would have to repeat in order. An example was given. "Repeat these numbers after me. 1, 3, 5." Subject responded. If any mistakes were made they were corrected at this point. Subject was then told that he would repeat the lists of numbers given to him just as he did in the example. Study 2 was used for all subjects. Subject was given the top list from the three digit group. If he responded correctly, he was then given the top list from the four digit group and so on. If he missed the top list from a group he was given a second chance with the bottom list from that group. The student's score was the largest group of digits in which he got at least one list correct.

Digit Span

Study 1

3:	3 8 6 6 1 2
4:	3 4 1 7 6 1 5 8
5:	8 4 2 3 9 5 2 1 8 6
6:	3 8 9 1 7 4 7 9 6 4 8 3
7:	5 1 7 4 2 3 8 9 8 5 2 1 6 3
8:	1 6 4 5 9 7 6 3 2 9 7 6 3 1 5 4
9:	5 3 8 7 1 2 4 6 9 4 2 6 9 1 7 8 3 5

Study 2

3:	5 8 2 6 9 4
4:	6 4 3 9 7 2 8 6
5:	4 2 7 3 1 7 5 8 3 6
6:	6 1 9 4 7 3 3 9 2 4 8 7
7:	5 9 1 7 4 2 8 4 1 7 9 3 8 6
8:	5 8 1 9 2 6 4 7 3 8 2 9 5 1 7 4
9:	2 7 5 8 6 2 5 8 4 7 1 3 9 4 2 5 6 8

APPENDIX H

W.P. WAGNER MATHEMATICS INVENTORY

W. P. WAGNER HIGH SCHOOL

MATHEMATICS INVENTORY

DO NOT WRITE ON THIS BOOKLET

DO ALL QUESTIONS, THERE IS NO PENALTY FOR ERRORS.

DO ANY CALCULATIONS NECESSARY ON YOUR OWN PAPER. CHOOSE THE BEST ANSWER FOR EACH QUESTION AND MARK YOUR CHOICE ON THE SEPARATE ANSWER SHEET. USE AN HB PENCIL ONLY. ERASE ANY ERRORS VERY CAREFULLY.

(2)

1.

$$\begin{array}{r} 406 \\ \underline{+230} \end{array}$$

a. 236
b. 600
c. 636
d. 646
e. 736

2.

$$\begin{array}{r} 2370 \\ \underline{-1890} \end{array}$$

a. 480
b. 840
c. 1480
d. 1580
e. 4800

3.

$$\begin{array}{r} 405 \\ \underline{\times\ \ 7} \end{array}$$

a. 2802
b. 2836
c. 2842
d. 2912
e. 28042

4.

$$5\overline{)535}$$

a. 17
b. 101
c. 107
d. 170
e. None

5.

$$\begin{array}{r} 3/4 \\ \underline{+1/8} \end{array}$$

a. 3/12
b. 4/12
c. 4/8
d. 7/8
e. None

6.

$$\begin{array}{r} 9 \\ \underline{-5\ 1/3} \end{array}$$

a. 3 1/3
b. 3 2/3
c. 4 1/3
d. 4 2/3
e. 14 1/3

(3)

7. $3/4 \times 1/4$

a. 4/8
b. 3/16
c. 4/16
d. 2 2/3
e. 3

8. $3/4 \div 1/4$

a. 3/16
b. 1/3
c. 1/2
d. 3
e. None

9. .04 + .143 + .3706

a. .3853
b. .4536
c. .5436
d. .5536
e. None

10. 43.4 - 3.15

a. .119
b. 1.19
c. 11.9
d. 40.25
e. None

11. $\begin{array}{r} 32.3 \\ \underline{\times\ .035} \end{array}$

a. .11305
b. 1.1305
c. 11.305
d. 113.05
e. 1130.5

12. $.03\overline{)\,.504}$

a. .057
b. 1.68
c. 16.8
d. 168
e. None

(4)

13. TWO MILLION TWO HUNDRED THOUSAND TWO IS:

a. 20,202
b. 200,202
c. 2,000,202
d. 2,200,002
e. None

14. FIVE EIGTHS IS:

a. 5-8
b. 8/5
c. .58
d. 5.8
e. None

15. THREE HUNDREDTHS IS:

a. 1/300
b. .03
c. .3
d. 300
e. None

16. 1/4 =

a. 4/10
b. .14
c. 4/16
d. .41
e. None

17. WHICH IS THE <u>LARGEST</u> NUMBER?

a. 3/4
b. 2/3
c. 8/9
d. 1/20
e. 5/8

18. CHANGE 3/8 TO A DECIMAL:

a. .375
b. .38
c. 3.8
d. 37.5
e. 375.

(5)

19. WHICH IS THE LARGEST NUMBER?
   a. .0255
   b. .099
   c. .7
   d. .015
   e. .0099

20. EIGHTY-FIVE PERCENT IS:
   a. .85%
   b. 85¢
   c. 85%
   d. 85°
   e. None

21. 4/5 =
   a. .45%
   b. 45%
   c. .8%
   d. 8%
   e. 80%

22. 3% =
   a. .03
   b. .3
   c. 3
   d. 30
   e. 300

23. 10% of 60 is:
   a. 600
   b. 50
   c. 6
   d. 1/6
   e. None

24. 16 IS WHAT PERCENT OF 40?
   a. 16/40
   b. 40
   c. 250
   d. 640
   e. None

(6)

25. IF $\frac{W}{4} = \frac{84}{28}$ THEN W =

a. 7
b. 12
c. 14
d. 24
e. None

26. THE DISTANCE TO (A) IN CENTIMETRES IS:

a. 18
b. .8
c. 1.8
d. 13
e. 25

27. SUBTRACT 12600 METRES FROM 20 KILOMETRES.

a. 12400 metres
b. 12580 metres
c. 12620 metres
d. 7400 metres
e. None

28. WHAT IS THE <u>AVERAGE</u> OF 9,18,27,36,45 and 54?

a. 31 1/2
b. 27
c. 189
d. 6
e. None

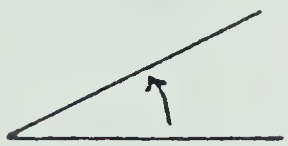
29. IN WHICH NUMBER DOES 3 REPRESENT THE <u>LEAST</u> VALUE?

a. 30,001
b. 19,300
c. 31,099
d. 70,739
e. Same

30. A PUPIL ROUNDED 7,328 TO 7,300. HE ROUNDED TO THE NEAREST:

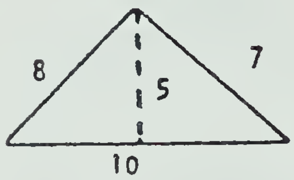
a. 10
b. 30
c. 100
d. 1000
e. Unknown

31. THIS ANGLE IS APPROXIMATELY HOW MANY DEGREES?



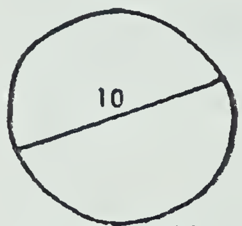
a. 3.14
b. 45
c. 90
d. 180
e. 300

32. FIND THE PERIMETER:



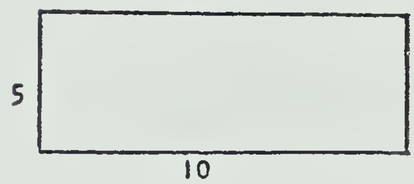
a. 25
b. 30
c. 50
d. 2800
e. None

33. FIND THE CIRCUMFERENCE:



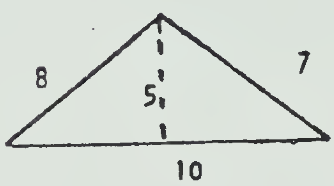
a. 3.14
b. 10
c. 20
d. 31.4
e. 78.50

34. FIND THE AREA:



a. 15
b. 25
c. 30
d. 50
e. None

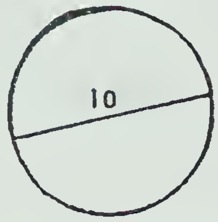
35. FIND THE AREA:



a. 25
b. 50
c. 560
d. 2800
e. None

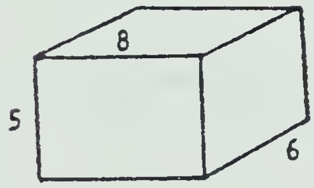
(8)

36. FIND THE AREA:



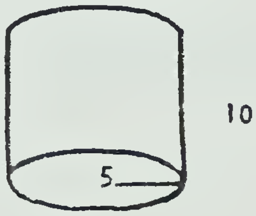
a. 3.14
b. 31.4
c. 78.5
d. 314
e. None

37. FIND THE VOLUME:



a. 19
b. 30
c. 40
d. 48
e. 240

38. FIND THE VOLUME:



a. 3.14
b. 50
c. 250
d. 785
e. None

39. FIND THE SURFACE AREA OF THE WALLS OF A ROOM 20 x 30 BY 8 HIGH.

a. 58
b. 60
c. 800
d. 4800
e. None

40. THE NUMBER OF CENTIMETRES IN 1 METRE IS:

a. .10
b. 100
c. 1000
d. 36
e. 12

(9)

41. THE NUMBER OF SQUARE CENTIMETRES IN 1 SQUARE METRE IS?

a. 100
b. 10
c. 10000
d. 1000
e. 3

42. THE NUMBER OF CUBIC CENTIMETRES IN 1 CUBIC METRE IS?

a. 1
b. 1000
c. 100
d. 1000000
e. 10000

43. IN CHANGING <u>METRES TO CENTIMETRES</u> YOU WOULD:

a. +
b. -
c. x
d. ÷
e. Depends

44. IF YOU BORROWED $100.00 FOR 1/2 A YEAR AT 6% INTEREST WOULD YOU OWE?

a. $3.00
b. $6.00
c. $300.00
d. $600.00
e. None

45. A FAMILY TOOK A VACATION IN THEIR CAR, IT LASTED ABOUT 2 WEEKS, THEY USED 150 GALLONS OF GASOLINE ON THE TRIP. TO FIND THE DISTANCE THEY TRAVELED, ON THE AVERAGE PER GALLON, YOU NEED TO KNOW:

a. the cost of gasoline per gallon
b. the average speed of driving
c. the number of hours travelled per day
d. the total number of miles they traveled
e. all of these

46. $\sqrt{36}$ =

a. 6
b. 13
c. 18
d. 169
e. None

47. 4^3 =

a. 7
b. 12
c. 64
d. 81
e. 256

48. 5 x = 45

x =

a. 5
b. 7
c. 9
d. 225
e. None

49. IF 56 ÷ N = 14

N =

a. 1/4
b. 4
c. 24
d. 728
e. None

50. IF r = 5, s = 6, t = 4, FIND THE VALUE OF x IF x = r + s - t

a. 7
b. 10
c. 11
d. 15
e. None

APPENDIX I

WORK SAMPLE BATTERY (JEVS)

WORK SAMPLE BATTERY (JEVS)

An explanation of successful performances achieved.

A client may attain a successful performance in one or more work aptitude groups. Each group contains certain skills or characteristics applicable to a wide variety of employment opportunities and related to the data, people and things hierarchy set out in the Canadian Classification and Dictionary of Occupations: 1971. This information is based on the premise that every job requires a worker to function in relation to data, people and things. None of the samples measures the client's ability to function in relation to people. Other factors, such as emotional and social maturity, physical disability, behaviour and work habits, must also be taken into account when considering suitable employment or placement of individual clients.

1. HANDLING: Basic work skills involving the use of body members (mainly hands), hand tools and/or special devices to work move or carry objects or materials. Involves little or no latitude for judgement with regard to attainment of standards or in selecting appropriate tool. object or material.
2. SORTING, INSPECTING, MEASURING & RELATED WORK: In addition to handling ability (above) the worker must make comparisons. An ability to judge the readily observable, functional, structural or compositional characteristics (i.e. similar or divergent from obvious standards) of data, people or things.
3. TENDING: The starting, stopping and observing the functioning of machines and equipment. Involves adjusting materials or controls of the machine, such as changing guides, adjusting timers and temperature gauges, turning valves to allow flow of materials, and flipping switches in response to lights. Little judgement is involved in making these adjustments.
4. MANIPULATING: As for handling (above) but involving some latitude for judgement with regard to precision attained and the selection of appropriate tool, object or material, although this is readily observable.
5. ROUTINE CHECKING & RECORDING: An ability to make comparisons, but without the demand to be skilled in handling ability (See sorting, Inspection& Measuring --- above). Closely related to clerical working ability.
6. CLASSIFYING, FILING & RELATED WORK: The ability to compile records. Gathering, collating or classifying information about data, people or things. Reporting and/ or carrying out a prescribed action in relation to the information is frequently involved.
7. INSPECTING & STOCK CHECKING: Computing ability. Performing arithmetic operations and reporting and/or carrying out a prescribed action in relation to them. There is a need for some handling skills.
8. CRAFTSMANSHIP & RELATED WORK: Requires precision working. The use of body members (hands primarily) and/or tools or work aids to work, move, guide or place objects or materials in situations where ultimate responsibility for the attainment of standards lies with the worker. The selection of appropriate tools, objects or materials, and the adjustment of the tool to the task requires considerable judgement. Also inherent is the ability to compile records and information.
9. DRAFTING & RELATED WORK: Involves precision working together with an ability to make an analysis: to examine and evaluate data. Presentation of alternative actions in relation to the evaluation is frequently involved.

APPENDIX J

WORK SAMPLE BATTERY (VIEWS)

WORK SAMPLE BATTERY: (VIEWS)

An explanation of specific skills observed.

Samples on which the client has worked are divided into worker aptitude groups. Each group contains certain skills or characteristics applicable to a variety of employment opportunities and related to the data, people and things hierarchy set out in the Canadian Classification and Dictionary of Occupations: 1971. This information is based on the premise that every job requires a worker to function in relation to data, people and things. None of the samples measures the client's ability to function in relation to people. Other factors, such as emotional and social maturity, physical disability, behaviour and work habits, must also be taken into account when considering suitable employment or placement of individual clients.

Elemental - HANDLING: Basic work skills involving the use of body members (mainly hands), hand tools and/or special devices to work, move or carry objects or materials. Involves little or no latitude for judgment with regard to attainment of standards or in selecting appropriate tool, object or material.
Elemental - FEEDING/OFFBEARING: Inserting, throwing, dumping or placing materials in or removing them from machines or equipment which are automatic or tended or operated by other workers.
Clerical - ROUTINE CHECKING & RECORDING: An ability to make comparisons, but without the demand to be skilled in handling ability (see Sorting, Inspecting & Measuring, below)
Clerical - SORTING, INSPECTING, MEASURING & RELATED WORK: In addition to handling abilit (above), the worker must make comparisons. An ability to judge the readily observable functional, structural or compositional characteristics (i.e. similar or divergent from obvious standards) of date, people or things.
Machine - TENDING: The starting, stopping and observing the functioning of machines and equipment. Involves adjusting materials or controls of the machine, such as changing guides, adjusting timers and temperature gauges, turning valves to allow flow of materials, and flipping switches in response to lights. Little judgment is involved in making these adjustments.
Crafts - MANIPULATING: As for Handling but involving some latitude for judgment with regard to precision attained and the selection of appropriate tool, object or material, although this is readily observable.

This Work Sample Battery looks at specific job/work skills as listed below. Therefore, when considering job placement it would be wise to look at jobs which possess only those particular aptitudes in which the client has shown him/herself proficient.

1. ELEMENTAL WORK SAMPLES
   measure such traits as: color matching ability; work rhythm; numerical ability; size, form and spatial discrimination; eye/hand coordination; and finger and manual dexterity. Tasks, involving the use of a variety of materials, include: sorting by color, size and shape; counting; cutting; collating; stapling; stamping; and assembly and disassembly.
2. CLERICAL WORK SAMPLES
   measure such traits as: numerical ability; elementary and middle level clerical perception; and the ability to learn a sequence of steps. Tasks include: weighing, number and shape matching; counting, recording; and use of hand tools.